# 27.

## Studies on Fish Parasites of Lake Erie. Distribution Studies.[1]

RALPH V. BANGHAM
*Department of Biology, College of Wooster, Wooster, Ohio*
*&*
GEORGE W. HUNTER, III[2]
*Shanklin Laboratory of Biology, Wesleyan University, Middletown, Conn.*

CONTENTS.



[1] This is the fourth of a series of papers on fish parasites of Lake Erie. The others contained descriptions of new species. See Bibliography. It was not feasible to include all of the more recent nomenclatorial changes in hosts and parasites. This is especially true of the Strigeidae.

[2] With the aid of a grant from the Charles Himrod Denison Research Fund in Biology.

## Section I. Introduction.

This study was initiated in 1928 as a part of the joint Cooperative Biological Survey of Lake Erie. The program was made possible through the cooperation of the United States Bureau of Fisheries, the New York State Conservation Department, the Ohio Division of Conservation and the Province of Ontario. The fish were collected from the east end of the lake only during the summer of 1928 while the collections from the opposite end extended from 1927 through 1929. In working on these collections emphasis was placed upon the helminths, although each fish was examined for evidence of infection by ectoparasites, as leeches, flukes and copepods. The primary object of this study has been threefold: (1) to identify the parasites collected, (2) to describe any new species encountered, (3) to study the regional distribution of these parasites and compare the infection (a) by families of fishes and (b) by degree of infestation.

During the early portion of this program much time was spent in identifying the various parasites encountered. During the interval from 1928 on, many of the species found were described by colleagues who had met these same forms in the course of their own work. Thus we are indebted particularly to the recent publications of Van Cleave & Mueller (1932, 1934) and Mueller & Van Cleave (1932), while Moulton (1931), Hopkins (1931, 1931a, 1934) and others have added adequate descriptions of other fish parasites. Many forms remained to be considered, however, and the earlier sections of the "Studies on Fish Parasites of Lake Erie" were confined to morphological descriptions of new species (Hunter & Bangham, 1932, 1933; Bangham & Hunter, 1936). The present paper is primarily an attempt to record the presence, distribution and severity of infection of the various fish parasites encountered. With so much recent and excellent material available it did not seem necessary to include figures of the parasites studied.

While finishing the manuscript the final section of the Lake Oneida studies was issued. While our material is treated in a somewhat different manner, nevertheless certain comparisons may be made. Van Cleave & Mueller (1934) record 90 species of worm parasites, while we found approximately 96, excluding 16 different ectoparasites. In the Oneida Lake studies 1,227 fish belonging to 34 species were examined while the present paper covers a total of 2,156, belonging to 79 species of fish. A further check reveals a surprisingly large number of parasites and hosts common to both localities.

A general survey of this type would be impossible without the able and willing assistance of many colleagues. Therefore the authors wish to acknowledge gratefully the assistance of the following: the United States Bureau of Fisheries, the New York State Conservation Department, the Ohio Division of Conservation and the Province of Ontario for furnishing the opportunity, funds and equipment necessary for this task; Mr. E. L. Wickliff, Ohio Division of Conservation, and Dr. J. R. Greeley, New York State Conservation Department, for the identification of the fish; Dr. Charles B. Wilson, State Normal College, Westfield, Mass., for the identification of the parasitic copepods from the east end of the lake; Dr. Andrew E. Zillig for material; Wanda Sanborn Hunter for many helpful suggestions and the compilation of much of the data; Mr. Wilbur N. Tidd for identification of parasitic copepods from the western end of the lake and for furnishing preserved parasites from more than 100 fish from the same area; the directors of the Stone Laboratory of Ohio State University and the State Fish Hatchery, both located at Put-in-Bay, Ohio, who furnished laboratory facilities where much of the preliminary work of examination and identification of parasites from the western region was done.

In this work the nomenclature of Dr. Carl L. Hubbs, Fisheries Institute, Ann Arbor, Michigan, has been followed in the host identification.

*Habitat*: Some information about Lake Erie may be gleaned from a

number of sources. However certain general features of the lake should be called to the reader's attention. In the first place, Lake Erie is the shallowest of the Great Lakes. For our purpose it may be roughly divided into three parts. The western end, extending from Peele Point, Ontario, to Cedar Point, Ohio, is characterized by great quantities of shoal water filled with many weed beds and is an area well adapted to the propagation of fish. The maximum depth for this area is about 8 fathoms. The middle region of Lake Erie (as designated here) extends from Peele Point to Long Point, Ontario, and from Cedar Point, Ohio, to the Pennsylvania-New York state line. This comprises the greatest portion of the lake from the standpoint of area. Here the shoreline drops off quite sharply and the maximum depth gradually increases from 7 to 8 fathoms at its western limits to the deep hole of 35 fathoms off Long Point. The eastern end includes the remainder of the lake, which gradually becomes more shoal as the mouth of the Niagara River is approached. The shore is much the same as that noted for the middle portion, with the exception of Long Point Bay which is a well-protected, shallow, weedy area forming an excellent breeding ground for fish.

There are many streams flowing into Lake Erie. The three largest inlets are the St. Clair, Maumee and Grand Rivers. All other inlets are much smaller. The shallowness of the western end of Lake Erie has been noted. Here the shore and surrounding terrain are likewise flatter than the more easterly portion, thus producing a more meandering type of stream. This is even more strikingly shown along the Canadian shore, while east of Sandusky, Ohio, the terrain becomes more rolling and many streams drop relatively rapidly to reach the lake. East of Silver Creek, N. Y., the country again becomes flatter. These differences are correlated in a general way with the amount of shallow water, the number of weed beds, etc., present in the lake proper.

## Methods of Collection and Preservation.

*Hosts*: The fish were secured from a variety of sources. Seining parties of the various interested groups secured many forms from the shallower waters. Trap nets and gill nets used in experiments on mesh at the west end of Lake Erie were set with those of the commercial fishermen, mainly towards Peele Island and off Cedar Point. Both of these devices were utilized extensively at the east end of the lake. In some instances material was secured through the commercial fishermen, principally those working out of Ashtabula and Sandusky, Ohio, Erie, Pa., and Port Dover, Ont. Trawls, hook and line, as well as set lines, were resorted to occasionally. Stations at the west end were visited at regular intervals during the summer months. The fish were always preserved in formalin and their identification verified by a competent ichthyologist.

*Parasites*: Insofar as possible the material was examined while it was still fresh. In some instances identifications were made on the living parasites, this being done whenever possible on the encysted Strigeidae. The parasites were preserved in 5% formalin, a saturated aqueous solution of mercuric chloride, Bouin's or Gilson's fixing fluids.

Wherever possible identifications were made from toto mounts. Carmine, alum cochineal, Delafield's and Ehrlich's hematoxylin were the stains which were used for trematodes, cestodes and Acanthocephala. Whenever the occasion warranted serial sections were made, the material being stained in Delafield's hematoxylin and counterstained with eosin. Tapeworms were frequently stained in a mixture of Ehrlich's and Delafield's hematoxylin. Nematodes were usually mounted unstained in glycerine jelly and ringed, or were studied as temporary mounts in lacto-phenol.

## Collecting Stations.

*Eastern End of Lake Erie*: The area herein designated as the eastern end of Lake Erie covers all of the lake east of an imaginary line drawn from Long Point, Ontario, to the New York-Pennsylvania state line. The area likewise includes the Niagara River, principally above the Niagara Falls, as well as mouths and the lower portions of the various tributary streams flowing into Lake Erie. The streams on the New York side were much more intensively covered than those along the Canadian shore.

There is much more shallow water (and therefore presumably better breeding grounds) in the western end of the lake. The vast middle portion of the lake, while not intensively studied, could scarcely be expected to yield markedly divergent results as the shore line resembles the eastern portion in many respects. In the first place, this large middle area of Lake Erie, as already noted, receives a series of short streams draining into the lake, which is also characteristic of the eastern end, and in the next place the 21-foot contour line extends about as far into the lake as it does along the eastern end (except for the Long Point region). The maximum depth of Lake Erie increases gradually from west to east, reaching the so-called deep hole of 35 fathoms off Long Point.

All of the collections at the eastern end were made between June and September in 1928. Most of the fish were secured from seine hauls along the shore, or at the mouths of streams. A few were collected by hook and line while others were received from the nets of various commercial fishermen. The Long Point Bay area was fairly intensively covered in a single expedition made during August. No regular seining stations along Lake Erie were established and in most cases a locality was only studied once. This was necessary as the Lake Erie studies were undertaken as a part of the survey of the entire Erie-Niagara watershed within the borders of New York. Consequently the picture is not as complete as that presented for the opposite end of the lake. Nevertheless we believed the work at both ends of the lake covered such different types of water that a study of fish parasites would yield really fundamental differences in parasitism.

There were 33 different localities in the eastern area from which fish were taken; of these 17 representing typical "lake" stations, i.e., several miles offshore or some spot along the lake shore other than the mouth of a stream; 3 were Niagara River stations and 13 were located at the mouths of streams flowing into the lake or Niagara River.

*Western End of Lake Erie*: The area discussed in this paper as the western end of Lake Erie is the region west of an imaginary line between Cedar Point, Ohio, and the tip of Peele Point, Ontario. This is a smaller portion of the lake but contains the chief spawning areas for many species of fish as it is relatively shallow, contains the necessary protection and has many islands. This is clearly shown by the greater distance the 21-foot contour line extends out into the lake.

During September, October and November, 1927, many of the fish examined for parasites were obtained from experimental trap and gill nets set off of Cedar Point and in the vicinity of Kelly's Island. Many fish were examined that were taken in the latter part of the summers of 1928 and 1929 from a Petersen fish trawl. Hauls from this trawl were taken from the regular stations in the open lake where limnological data were obtained. The greater number of the fish studied from this area were secured in seine hauls made in selected areas along the shore line and along the islands. Two seining trips were made during the summer of 1928 and four at intervals of about three weeks during that of 1929. A 100-foot seine was used at all stations and an effort was made at each haul to cover an area of 10,000 square feet. The net used was graded from three-fourths inch square mesh on the ends to one-eighth inch square mesh in the bag.

The 40 seining stations in this area include the following: 7 in Sandusky Bay, 5 of which were filled with weeds and large stones, the 2 on the west side of the Bay near the lake being shallow with sand bottoms; 10 along the Ohio shore, located at intervals from west of the mouth of Sandusky Bay to the Maumee Bay, with sand or gravel bottoms with occasional patches of pond weeds or rushes; 4 inside Maumee Bay, those on the east side near the lake being filled with pond weeds and those farther inside with but little vegetation and a bottom of oil-saturated clay; 3 along the Michigan shore, which were shallow with scattered rushes and pond weeds; 3 along the Canadian shore from near the mouth of the Detroit River to the vicinity of Kingsville, Ontario; 13 along the shores of Kelly's, Middle, Peele, East Sister, North Bass, Sugar, Middle Bass and South Bass islands where a suitable area was located. In protected bays weed beds were encountered and in more open places the bottom was of sand or gravel. In addition to these stations occasional visits were made to the shallow, weedy, spawning areas in East and West Harbors and in the "ponded" portion near the mouth of the Portage River above Port Clinton. The fish secured in these latter areas were chiefly young forms.

The data for a few fish secured outside the designated area are included in the tables and descriptions of parasites of fish from the western area. These are chiefly records for cisco, whitefish and the long-nosed dace.

## Section II. Parasitism in General.

*Historical Account of Studies upon Fish Parasites.* Although the literature upon fish parasites is quite extensive it should be recalled that most of the work has been done within the last forty years. Futhermore it should be borne in mind that most of the forms encountered by the early workers were new to science. Consequently most of these contributions were of a strictly taxonomic nature. Perhaps the best known worker of this early era was Leidy who described many new parasites from 1851 to 1888. Linton (1891-1925), who followed him, began to produce more ecologically-framed papers, particularly those dealing with salt water forms. Herein attention will be directed toward the parasites of fresh water fishes. Other workers of the same general era, who made contributions to the morphology of parasites, were Ward (1894-1918), Stafford (1900-1904), Marshall & Gilbert (1905), Osborn (1902-1919) and Cooper (1914-1920).

The first adequate summary of this early literature was made by Pratt (1900-1902) and Ward & Whipple (1918) brought the American literature upon the subject up to date. Intensive monographic taxonomic studies of small groups of fish parasites and others have been undertaken principally by Dr. Ward and his students. Ward (1910) investigated the parasitic fauna of the Sebago salmon. Some of these studies contained a limited amount of material on host relationships. Thus LaRue (1914) published a monograph upon the Proteocephalidae, while Cooper (1919), Manter (1926), Essex (1928), Hunter (1930) and Hopkins (1934) published respectively upon the Pseudophyllidea, Azygiidae, Corallobothrium, Caryophyllaeidae and Allocreadiidae. More recent publications should include the taxonomic contributions of Van Cleave & Mueller (1932) and Mueller & Van Cleave (1932). Other workers who have contributed are legion. Some of the more important of them might be mentioned: Bangham (1925, 1927), Cooper (1915, 1920), Cort (1913), Essex (1928, 1928a, 1928b, 1929, 1929a), Faust (1918, 1919), Guberlet (1922, 1927, 1929), Holl (1928, 1929, 1929a), Hughes (1927-1929), Hunter (1927-1933), the Hunters (1929-1934), LaRue and his group of students and associates (1909-1932), Mueller (1930, 1933, 1934), Simer (1929, 1931), Thomas (1929, 1930), Woodhead (1926, 1929, 1930, 1932) and Van Cleave (1916, 1919).

Interest in the distribution, degree of infection and other more complex aspects of the host-parasite relationship as viewed from an ecological angle has been largely lacking. Probably the first contribution of this type is Ward's (1894) record of an examination of 20 species of fish from Lake St. Clair. Marshall & Gilbert followed this in 1905 by a study of the food and parasites of 13 species of fish taken from the lakes near Madison, Wisconsin. Several years later Ward (1912) published accumulated data on 991 fish representing 62 species. These data were treated statistically and the various percentages of infection with different groups of parasites were recorded. Cooper (1915b) contributed to our knowledge of the regional distribution of fish parasites from Canadian waters while Pearse (1924) studied the parasites of the yellow perch. Throughout the year and later (1924a) he treated of parasitism in fishes taken from the upper Mississippi (Lake Pepin) and certain Wisconsin lakes. Essex & Hunter (1926) recorded data from 652 fish and compared the percentage of infection in fishes from lakes and rivers in the various classes of helminths. This was followed in 1933 by a paper by Dolley who studied the distribution of plant and animal forms along the St. Joseph River. Other surveys of fish parasites have been made by the Hunters from 1929 on as a part of the New York State Conservation Department's Biological Survey Program. These have dealt primarily with distribution of various parasites and the general degree of infestation in the fishes of different watersheds.

Cross (1933, 1935), in studying host-parasite relationships of fish from Wisconsin lakes, suggests that certain parasites have a retarding effect upon the growth of their hosts. In 1934 he cited evidence for a case of non-specific immunity between Acanthocephala and tape worms of the cisco.

Adams & Hankinson (1928) contributed to our knowledge of the fishes of Oneida Lake and included some data on fish parasites gleaned from the literature. Holl (1932) makes an ecological analysis of certain fish and amphibian parasites. Van Cleave & Mueller in 1934 presented their completed ecological analysis of the fish hosts and their parasites from Oneida Lake.

*Parasitism in General:* During this study 2,156 fish belonging to 79 species and 22 families were examined and of this number 1,257 or 58.3% were found to harbor one or more species of parasites. This represents a moderately high degree of infestation since numerous young fish are included. Essex & Hunter (1926), in a study of fish parasites from lakes and streams of the central states, found 39% of 652 fish infested with parasitic worms. However, they examined a relatively large proportion of fish which generally have but few parasites. When these, gizzard shad, carp and young channel catfish were excluded from their computations, nearly 50% of the remainder carried some form of parasitic helminths. Bangham in 1930 made a study of fish parasites of Buckeye Lake, a comparatively small Ohio Lake of approximately 4,200 acres. The unpublished data show that 65.7% of 514 fish harbored one or more species of parasites. These fish belonged to the same families as those covered in the Lake Erie study. The number of different parasites encountered was much less in the Buckeye Lake fish than in the same host taken from Lake Erie. Species of fish examined that had been secured from streams flowing into Lake Erie yielded both fewer parasites and a smaller variety of infecting forms than the same species of fish taken from Lake Erie. The data of stream fish are not included in this report and are unpublished except for a portion of the records covering large- and small-mouthed black bass (Hunter & Hunter, 1931, and Bangham, 1934).

As will be pointed out in numerous instances in comparisons of individual species taken at opposite ends of Lake Erie, there is very often a larger variety of infesting forms and a higher degree of infection in the fish examined from the western area. The reason for this condition appears to

be the greater area of shallow, warmer water and weedy regions favorable to the production and growth of quantities of snails, crustacea and small fish, which act as primary hosts for many of the fish parasites.

The majority of the fish examined belonged to six families as follows: 108 to the Coregonidae, 92 to the Catostomidae, 672 to the Cyprinidae, 75 to the Ameiuridae, 428 to the Percidae and 395 to the Centrarchidae. These yielded respectively 52.7, 28, 43.3, 73.3, 69.4 and 73.6% infection by parasites. In the family Esocidae two species were examined while in the remaining 15 families but a single species of fish was examined in each. In certain groups such as Gasterosteidae, Cottidae, Salmonidae, Atherinidae and Umbridae there were but one or two kinds of parasites found in each fish. In the Amiidae, Lepisosteidae, Percopsidae, Percidae, Centrarchidae and Sciaenidae many different forms were often encountered in each infected fish. Individuals belonging to the last group of families include many larger forms which frequently have as a part of their diet smaller fish carrying larval stages of parasites which mature in these carnivorous fish. With the exception of the trout perch belonging to the Percopsidae and the darters of the Percidae, the fish harbored a majority of adult parasites.

Even though certain Lake Erie fish carry a large variety of species, parasites are not in general a serious menace. So far, no infestations of epidemic nature have been found although most of the forms which cause outbreaks under the crowded, somewhat unnatural conditions of the inland hatcheries were secured from these lake fish. A large proportion of the fish free from parasites were either young or adults belonging to a few species such as stickleback, miller's thumb, gizzard shad, carp and most of the suckers. In the tables giving parasitism by families, whenever young fish were examined they were separated from the adults in compiling the data.

*Parasitism and Pollution*: No correlation could be established between water pollution and degree of infestation. Fish taken from Maumee Bay near Toledo and from the lake shore near the mouth of the Detroit River were not more heavily infected than the same species obtained from the relatively clean water near the shores of the Bass Islands. However, fish secured from the weedy marshes which open into Lake Erie near Port Clinton, Ohio, did show a higher degree of infestation for almost all fish species when compared with the same forms taken along the shore of the lake. This shallow, clean water was an ideal breeding area for many fish as well as for numerous snails, Copepoda, Cladocera, Amphipoda and other forms which act as first intermediate hosts for the parasites of these fish.

*Parasitism and the Host:* Larval stages of certain helminths often reach young fish early in their development. Six young small-mouthed black bass 10 to 15 mm. in length taken June 17, 1928, had from 1 to 10 larval plerocercoids, *Proteocephalus pearsei* LaRue, in their intestinal tracts. Three young large-mouthed black bass 11 to 18 mm. in length taken June 28, 1929, from West Harbor carried from 2 to 10 mesentery cysts of a cestode, probably *Proteocephalus ambloplitis* (Leidy). Young whitefish were obtained in the Petersen trawl in May and June, 1928, from the western portion of the lake. Four of these measured 18, 24, 26 and 30 mm., respectively, and carried 3 to 9 larval cestodes in their intestinal tracts. One was approaching maturity and was identified as *Proteocephalus exiguus* LaRue. The smallest pike perch examined was a 27 mm. individual secured June 27, 1929, and it carried in its intestine four larval cestodes which belonged to the species *Proteocephalus stizostethi* Hunter & Bangham. All of these cestode parasites were found while the food of the young fish was chiefly limited to smaller Entomostraca. As the fish became larger and changed their food habits the parasitic fauna became more varied.

In a few instances the parasitism caused noticeable harm to the host as seen in the case of sterility in large-mouthed and small-mouthed black

bass due to an infestation in the reproductive organs of larval cestodes, *Proteocephalus ambloplitis* (Leidy). Emaciation in certain fish appeared correlated with the presence of hundreds of Acanthocephala whose spiny proboscides were embedded in the intestinal walls. Some fish, notably the spot-tailed minnow, carry in their body cavities 1 to 5 larval cestodes, *Ligula intestinalis* (Linn.). These render the host potbellied and sluggish; such fish are easily captured by birds constituting the definitive host. Many fish such as certain adult whitefish, yellow perch and pike perch often carry large numbers of small to medium-sized cestodes free in their intestinal tracts with but little apparent injury to the host. The mesenteries were full of fat and the fish appeared to be vigorous. The commercial value of many fish is destroyed even though there may be no great physical harm to the host, through the presence of the disfiguring lymphocystis disease or the presence of encysted metacercariae under the scales and throughout the flesh. Both saugers and pike perch were found to be so afflicted.

Although these fish were examined carefully, no evidence of fish infected with the plerocercoid larvae of the broad tapeworm of man, *Diphyllobothrium latum*, was found.

*Parasitism by Families of Fish*: As was mentioned previously, representatives of 22 families of fish were examined for parasites. In some instances sufficient numbers of individuals were not examined to warrant any conclusion being drawn, but in other cases it is apparent that there is ample material. Certain sources of error should be borne in mind as, (1) the difference in numbers of a given species examined from either end of the lake; (2) the absence of any appreciable numbers of fish from the central portion of the lake; (3) the inclusion of a few records of fish which should be definitely characterized as stream fish; (4) the impossibility of always procuring comparable samples through the use of identical equipment; (5) the collection of samples from given stations at the western end compared with a single visit to comparable locations in the eastern end. This is one of the most serious drawbacks, for repeated visits probably resulted in a more complete picture of the parasitic fauna than could be ascertained by a single visit.

However, it is the sincere hope of the authors that the attempt to bring together data on the parasites of 2,156 fish representing 79 of the reported 95 species from one of the largest fresh water lakes ever studied in this fashion, will prove to be sufficiently useful to warrant the overlooking of certain unavoidable discrepancies in planning and execution of this program. Much closer cooperation would have been possible if we had become imbued with the idea of formulating a joint paper at the beginning of the work instead of the end. Certainly there is a real advantage to the joint recording and study of these data over the separate publication of reports upon the parasites of fish from the eastern and western ends. In a surprisingly large number of cases the numbers of hosts are sufficient to warrant comparisons.

Two tables are appended. Table A indicates the total number of fish examined from each family and the percentage of those which were infected. A glance at this shows that the Lepisosteidae (88.8 %), Amiidae (100 %), Salmonidae (63.5 %), Esocidae (61.5 %), Percidae (69.4 %), Centrarchidae (73.6 %), Sciaenidae (91.6 %) and the Gadidae (100 %) might all be grouped together. These figures are of course based principally upon examinations of adult fish. It should be pointed out that these roughly fall into the groups of so-called "carnivorous or piscivorous fishes," a large proportion of whose diet consists of other good-sized fish, other vertebrates and certain of the larger invertebrates, as the molluscs, crustacea and insects. If we add the Percopsidae (82.4 %) and the Ameiuridae (73.3 %), we have all the fish families having more than the average percentage of infection. It is interesting to note that the species examined by us as representatives of

these families are all known to include significant quantities of other fish, aquatic larvae, crustacea and molluscs, all of which in turn are known to carry helminths in various intermediate stages of development. On the other hand, those which specialize upon plants, or some one group as bottom feeders, like so many of the Cyprinidae (43.3 %), or plankton feeders, as the Gasterosteidae (18.1 %), show a percentage of infection significantly below the average. While this correlation has not been checked mathematically, it would appear that a fair correlation might be expected.

TABLE A.

Percentage of Parasitism by Families of Fish.

| *Family* | *Number Examined* | *Percentage Infected* |
|---|---|---|
| 1. Acipenseridae | 2 | 100.0 |
| 2. Lepisosteidae | 9 | 88.8 |
| 3. Amiidae | 4 | 100.0 |
| 4. Hiodontidae | 28 | 53.8 |
| 5. Clupeidae | 5 | 20.0 |
| 6. Coregonidae | 108 | 52.7 |
| 7. Salmonidae | 63 | 63.5 |
| 8. Catostomidae | 92 | 28.2 |
| 9. Cyprinidae | 672 | 43.3 |
| 10. Ameiuridae | 75 | 73.3 |
| 11. Umbridae | 12 | 50.0 |
| 12. Esocidae | 13 | 61.5 |
| 13. Cyprinodontidae | 31 | 41.9 |
| 14. Percopsidae | 53 | 82.4 |
| 15. Serranidae | 34 | 88.2 |
| 16. Percidae | 428 | 69.4 |
| 17. Centrarchidae | 395 | 73.6 |
| 18. Atherinidae | 45 | 22.2 |
| 19. Sciaenidae | 48 | 91.6 |
| 20. Cottidae | 7 | 28.6 |
| 21. Gasterosteidae | 22 | 18.1 |
| 22. Gadidae | 10 | 100.0 |
| Total examined | 2,156 | |
| Total parasitized | 1,257 | |
| Percentage infected | 58.3 | |

The three families with the lowest percentage of infection are the Gasterosteidae with only 18.1 %, the Clupeidae with 20 %, the Atherinidae with but 22.2 %. Unpublished data (Hunter & Grant) on the first family indicates a decided preference for plankton with larvae (as *Chironomus*) coming in at certain seasons of the year. Members of the next two groups are listed by Sibley (1929) as being groups whose diet was primarily plankton. It would thus appear that those families of fish whose food is largely secured from plankton would be correlated with a lower degree of parasitism.

Table B is an attempt to furnish some concept of the numbers examined of each family of fish. This does not, of course, mean that the same species were always included nor even the same numbers of a given species. But again it does suggest that we may be hopeful of securing sufficient data for comparison of the families as a whole (assuming more or less equal representation of species) in some of the cases. One fact stands out quite clearly—the fish from the western end of Lake Erie are more universally infected than those from the eastern end. This also holds for given families, as the Hiodontidae, where there is a difference of nearly 40%, the Ameiuridae with differences of more than 65%, and the Centrarchidae with about a 20% discrepancy. Probably the Cyprinodontidae should be included as there is a range of 21.4 to 58.8% between those taken from the eastern and western extremities of Lake Erie. Others which show rather striking differences are

the Catostomidae with a difference of something more than 60% and the Atherinidae whose extremes ranged between uninfected fish and a one-third infection at the western end. Possibly the Coregonidae should be included, too, except for the assumption that they are even more migratory than the others which were encountered. Likewise both the Cyprinidae and Percidae might be mentioned although the differences are not so marked. The Esocidae furnish the only divergence from this general plan, for in this one instance the Esocidae were all infected in the eastern region while less than 30% from the opposite end were carrying parasites.

TABLE B.

Comparison by Regions of Percentage of Parasitism by Families of Fish.

| | *Eastern End* | | *Western End* | |
|---|---|---|---|---|
| *Family* | *Number Examined* | *Per cent. Infected* | *Number Examined* | *Per cent. Infected* |
| Acipenseridae | 0 | 0 | 2 | 100.0 |
| Lepisostidae | 1 | 0 | 8 | 100.0 |
| Amiidae | 0 | 0 | 4 | 100.0 |
| Hiodontidae | 16 | 37.5 | 12 | 75.0 |
| Clupeidae | 0 | 0 | 5 | 20.0 |
| Coregonidae | 72 | 30.0 | 36 | 97.2 |
| Salmonidae | 63 | 63.5 | 0 | 0 |
| Catostomidae | 77 | 18.1 | 15 | 80.0 |
| Cyprinidae | 326 | 37.4 | 342 | 48.8 |
| Ameiuridae | 15 | 20.0 | 60 | 86.6 |
| Umbridae | 3 | 0 | 9 | 66.6 |
| Esocidae | 6 | 100.0 | 7 | 28.5 |
| Cyprinodontidae | 14 | 21.4 | 17 | 58.8 |
| Percopsidae | 7 | 71.4 | 46 | 95.7 |
| Serranidae | 2 | 50.0 | 32 | 90.6 |
| Percidae | 137 | 59.8 | 291 | 73.8 |
| Centrarchidae | 113 | 59.3 | 282 | 79.4 |
| Atherinidae | 15 | 0 | 30 | 33.3 |
| Sciaenidae | 3 | 100.0 | 45 | 91.1 |
| Cottidae | 0 | 0 | 7 | 28.6 |
| Gasterosteidae | 20 | 15.0 | 2 | 50.0 |
| Gadidae | 3 | 100.0 | 7 | 100.0 |

## SECTION III. A COMPARISON OF PARASITISM WITHIN THE FAMILIES OF FISH.

In the following pages, we have discussed the parasites in the different families of fish. As complete records are given in the tables, this discussion is merely to emphasize salient points and summarize findings listed.

### ACIPENSERIDAE.

LAKE STURGEON, *Acipenser fulvescens* Rafinesque: Two specimens of the lake sturgeon were the only members of this family examined. These were taken from pound nets near Peele Isle. Both individuals carried small numbers of the trematode, *Crepidostomum lintoni* (Pratt in Linton, 1901) and the nematode *Cucullanus clitellaris* Ward & Magath, while one was infected with *Allocreadium* sp.

### LEPISOSTEIDAE.

LONG-NOSED GAR, *Lepisosteus osseus* (Linn.): The long-nosed gar was the only representative of this family examined and the single specimen from the east end was uninfected. Eight taken in seine hauls from the west end were all heavily infested. Seven harbored numerous encysted ple-

rocercoids of *Proteocephalus ambloplitis* (Leidy); these were found chiefly in the liver. *Proteocephalus singularis* LaRue were found as adults in the intestinal tracts of six fish. The trematode *Macroderoides spiniferous* Pearse was found in small numbers in five fish. Two specimens only carried nematodes; these constituted a new species and have been described as *Cystidicola lepisostei* (Hunter & Bangham, 1933). *Bothriocephalus* sp. and *Leptorhynchoides thecatus* were each present in one fish.

### Amiidae.

Bowfin, *Amia calva* Linn: This species was taken only from the western end of Lake Erie. Three adults and one young yielded a 100% infection. One small adult had 25 adult *Proteocephalus ambloplitis* (Leidy), 8 *Crepidostomum cornutum* Osborn, 15 *Microphallus opacus* Ward, one *Haplobothrium globuliforme* Cooper and one *Haplonema immutatum* Ward & Magath in its intestinal tract. *Macroderoides typicum* (Winfield), *Leuceruthrus micropteri* Marshall & Gilbert and the acanthocephalid, *Leptorhynchoides thecatus* (Linton), were also present in this species. This relatively large number of parasites further substantiates the findings in other localities (Ward (1912), Essex & Hunter (1926), Hunter & Hunter (1930, 1932) ). Five species of parasites found in the bowfin were also secured from the small-mouthed black bass. These were *P. ambloplitis, C. cornutum, M. opacus, L. micropteri* and *L. thecatus.* The small-mouthed black bass was found in the few locations where the bowfin was secured and also in more open waters in many other areas. According to Forbes & Richardson (1909), Coker (1917) and Rimsky-Korsakoff (1930), the food of the bowfin is chiefly animal, being composed largely of fishes with smaller numbers of crayfish, molluscs and adult insects comprising the remainder of the diet.

### Hiodontidae.

Moon-eye, *Hiodon tergisus* Le Sueur: A total of 28 moon-eyes, *Hiodon tergisus,* were examined from Lake Erie. Two species of nematodes only were recovered from the 16 fish from the east end; these were *Rhabdochona cascadilla* Wigdor (1918) and *Camallanus oxycephalus* Ward & Magath (1917). The 12 fish from the west end harbored the same two nematodes. It should be noted that the fish from the west end not only carried a slightly heavier infection with these parasites, but also were infected by both trematodes and cestodes.

Three-fourths of the fish from the west end were infected compared with the 37.5% of the fish from the east end. Two of the trematodes were identified to genus only, *Leuceruthrus* and *Tetracotyle,* while the third proved to be *Crepidostomum illinoiense* Faust, 1918. Pearse (1924, 1924a) reports *C. illinoiense* from the moon-eye from Lake Pepin in the Mississippi River. Hunter in unpublished records on 8 more *Hiodon tergisus* from the St. Lawrence River and Black Lake, N. Y., reports three individuals carrying *C. illinoiense* as well as two with unidentified nematodes. The tapeworms encountered were an immature proteocephalid and *Bothriocephalus cuspidatus* Cooper (1917).

In this connection it might be recalled that Forbes (1888) found the food of five specimens of the moon-eye to consist wholly of insects (two-thirds of them terrestrial) with the exception of a trace of univalve Mollusca. Sibley (1929), in specimens 106 to 146 mm. long, found some *Cladocera* (6%) but terrestrial insects were the most abundant food. Boesal (unpublished data) reports on the food of 17 moon-eyes from the western area of Lake Erie obtained from five seining stations, three of which had sandy bottoms either lacking vegetation or with scattered *Potamogeton* and

*Scirpus* while the other two had hard clay bottoms with *Potamogeton* extending far out into the lake. All specimens not over 39 mm. in length fed on Entomostraca while those above 57 mm. fed entirely on insects and amphipods. These older forms had secured their food largely from the surface of the water.

With this host there appears a rather striking difference between the parasites encountered in fish from the opposite ends of the lake. As pointed out elsewhere this difference is undoubtedly partially attributable to the relatively greater area of the west end which is given over to shallow, weedy regions which are naturally productive of great numbers of first intermediate hosts of the helminths.

### Clupeidae.

Gizzard shad, *Dorosoma cepedianum* (Le Sueur): The gizzard shad was not often taken in our collections from Lake Erie; none were collected from the eastern end. In all, only five specimens were examined; one young fish had an unidentified larval nematode in the intestine. According to Tiffany (1921) these fish mainly feed on phytoplankton and are valuable food for game fish when they occur in sufficient numbers.

Van Cleave (1916), in reporting on the examination of 300 gizzard shad for parasites, found but two species of Acanthocephala belonging to the genus *Neoechinorhynchus*. He found that *Gracilisentis gracilisentis* (Van Cleave, 1913) enters this host in early fall and in April or May it attains sexual maturity and is lost from the host, not being found during the summer. On the other hand, *Tanaorhamphus longirostris* (Van Cleave) parasitizes the gizzard shad in the summer, reaching full sexual maturity by midwinter, disappearing entirely from spring to early summer. Essex & Hunter (1926) report no parasites in an examination of over a hundred gizzard shad taken from the Rock and Mississippi Rivers. Gizzard shad are very abundant in Buckeye Lake, Ohio, where the Ohio Division of Conservation conducted a survey in 1930. Here they often carry a very heavy infestation of a myxosporidian which forms large white cysts in the body cavities of the fish. The losses due to this type of infestation are especially high in young fish during the late summer and early fall, August and September. All of fifteen adult gizzard shad from Buckeye Lake examined by Bangham (unpublished data) were free of parasites and ten of twelve young carried many of the above mentioned encysted forms. These small fish were often quite "pot-bellied."

### Coregonidae.

A total of 108 fish belonging to two species, the lake herring, *Leucichthys artedi* (Le Sueur), and the whitefish, *Coregonus clupeaformis* (Mitchill), were examined from this family. In the latter species, the young and adults were considered separately.

Lake Herring or Cisco, *Leucichthys artedi* (Le Sueur): Sixty-three lake herring were obtained from the east end and yielded a 25.4% infection compared with 15 obtained from the west end, 14 of which, or 95.5%, were infected. *Proteocephalus exiguus* LaRue was the dominant parasite in both areas; *P. wickliffi* Hunter & Bangham (1933) also was present in both regions, while *Abothrium crassum* (Bloch) was found only in fish from the west end.

Neither trematodes nor Acanthocephala were found in this species, and the nematodes were represented in but one instance at the west end where *Cystidicola stigmatura* (Leidy, 1886) was found encysted in the wall of the air bladder.

WHITEFISH, *Coregonus clupeaformis* (Mitchill): Nine whitefish were examined from the east end of the lake and of these 6 carried *P. exiguus* and one had an adult *A. crassum*. All of 15 adults and 6 young whitefish from the other end of the lake carried parasites. The only parasites of the young fish were larval and partly mature *P. exiguus*. These forms are obtained with the first food as two young whitefish 18 mm. long carried two each of plerocercoids similar to those in older fish which could be identified as *P. exiguus*. A young whitefish 30 mm. in length had 8 larval and one adult *P. exiguus*. Only three of the adult fish in this group carried this cestode but two of these fish each had from two to three hundred individuals in their upper intestinal tracts. The young fish and the three adults just referred to were examined in the summer while the remainder of the whitefish from the western area were obtained and examined in the fall.

The infestation of *P. exiguus* may be seasonal. As these fish feed on animal plankton as well as molluscs, they may obtain these cestodes directly from the first intermediate host. To quote Forbes & Richardson (1920), "The gill-rakers of the adult are of a size and number to enable it to separate from the water organisms as small as Entomostraca, and where these are abundant they make a large percentage of the food." Sibley & Rimsky-Korsakoff (1931) record 100% animal plankton for 18 whitefish and 70% animal plankton and 30% snails for two other fish taken later. Unpublished data on the food of the whitefish of western Lake Erie bear out these findings. In a 39 cm. whitefish from the Kelly's Isle region a plerocercoid was found in the auricular cavity. This appears to be similar to the one referred to by Linton (1925), Moore (1925, 1926) and identified later as *Schistocephalus* sp. by T. B. Magath. In certain regions species of coregonid fishes are so heavily infested with this form that it is a problem of real economic importance. Moore (1926) refers to the high frequency of infection in whitefish of Upper Saranac and Clear Lakes. These fish were introduced from the Great Lakes and have a higher mortality than the frostfish *Prosopium quadrilaterale* (Richardson) which are native to these lakes. Hunter & Hunter (1930) report finding this form in larger numbers in the frostfish of Chazy Lake, New York. The total infection with this *Schistocephalus* sp. at Chazy Lake was 17.7% and was much higher in fish found dead along the shore than in fish obtained in gill nets.

No significant comparison can be made between the degree of infestation of the fish in the two areas of the lake, as data for certain fish from the middle of the lake were obtained by both authors and are contained in the table for the western area. Furthermore, these fish migrate in the fall from the deeper eastern waters to their spawning beds in the shallower region at the opposite end.

### SALMONIDAE.

BROOK TROUT, *Salvelinus fontinalis* (Mitchill): Sixty-three brook trout were examined from the upper portions of streams flowing into eastern Lake Erie, between Buffalo and the Pennsylvania State line. Forty of these carried light infections of the nematode *Cystidicloides harwoodi* (Chandler). These findings corroborate those of Hunter & Hunter (1931) who called attention to the fact that brook trout from streams in that portion of New York harbored only intestinal nematodes.

### CATOSTOMIDAE.

The parasite fauna of this family is important since its members constitute a significant part of the diet of game fishes (Sibley, 1929). Seven species from four genera of fish were represented in the total of 92 examined. These were the white carp, *Carpiodes cyprinus* (Le Sueur); common sucker, *Catostomus commersonnii* (Lacépède); hog sucker, *Hypentelium nigri-*

*cans* (Le Sueur); red-fin mullet or red horse sucker, *Moxostoma aureolum* (Le Sueur); fine-scaled red-fin mullet or red horse sucker, *Moxostoma duquesnii* (Le Sueur); short-headed red-fin mullet or red horse sucker, *Moxostoma lesueurii* (Richardson); white-nosed red-fin mullet or red horse sucker, *Moxostoma anisurum* Raf.

Seventy-seven were examined from the eastern end and 15 from the western area. Of these 14 and 12, respectively, were infected, thus showing clearly a heavier infection at the latter end. This is further substantiated by the presence of only 7 species of parasites from the eastern area contrasted with 10 from the western.

WHITE CARP, *Carpiodes cyprinus* (Le Sueur): Thirteen of the 16 fish examined were from the east end and 5 of these were infected with *Rhabdochona cascadilla* Wigdor, one harbored *Hypocaryophyllaeus paratarius* Hunter. The three from the western area were negative.

COMMON SUCKER, *Catostomus commersonnii* (Lacépède): Eight of 13 from the east end were infected; four carried *Glaridacris catostomi* Cooper; two, *Ligula intestinalis* in the body cavity; one, *Triaenophorus nodulosus* larva and three carried *Octospinifer macilentus*. All 8 examined from the west end were infected; one carried larval *Triaenophorus nodulosus;* one, larval *L. intestinalis;* another *Agamonema;* four, *Neoechinorhynchus crassus;* one, *O. macilentus* and two harbored *Pomphorhynchus bulbocolli.*

HOG SUCKER, *Hypentelium nigricans* (Le Sueur): In all, 21 were examined and all but one were free from parasites. This one was the sole specimen taken from the west end and it carried only a slight infection of Myxosporidia.

RED HORSE SUCKERS, *Moxostoma aureolum* (Le Sueur), *M. duquesnii* (Le Sueur), *M. lesueurii* (Richardson) and *M. anisurum* Raf: One of the two common red horse suckers (*M. aureolum*) from the east end carried a nematode; nothing but a few encysted metacercariae belonging to the genus *Neascus* were found in the one from the west end.

Fourteen *M. duquesnii,* all from the east end, were negative. Six *M. lesueurii* from the east end were negative while the two from the west end were both parasitized; one with *Rhabdochona cascadilla* Wigdor and one with Myxosporidia.

Nine *M. anisurum,* all from the east end, were negative.

As is shown in the above, the common sucker, *C. commersonnii,* is the species most heavily infected. However, none of the parasites encountered in the various members of the family was found in sufficient numbers to be of economic significance.

## CYPRINIDAE.

A total of 672 fish from 23 species and 13 genera of Cyprinidae were examined from both ends of Lake Erie. It is significant to note in this connection that 326 fish came from the eastern end of the lake compared with 346 from the western end. Of these 122, or 37.7%, and 167, or 48.2%, respectively, were infected. These figures indicate rather forcibly the fact, more or less apparent heretofore, that the fish from the western end of Lake Erie may be expected to be more heavily parasitized. In addition the table shows that the infection deals with about an equal number of species of parasites since 13 were encountered in minnows from the east end compared with 14 from the west end. This condition is not typical, as a greater variety of parasites has usually been encountered in the fish taken from the west end of the lake. The equality of the infection data can undoubtedly be accounted for by the similarity of the environments of these fishes. Regardless of the locality from whence they came identical species would be found in similar environments. In order to make comparisons easier the species of fish and the number examined are listed in the following table.

| Species | Number examined from east end | Number examined from west end |
|---|---|---|
| (1) German carp, *Cyprinus carpio* (Linn.) | 7 | 6 |
| (2) Goldfish, *Carassius auratus* (Linn.) | 2 | 11 |
| (3) River chub, *Nocomis micropogon* (Cope) | 18 | .. |
| (4) Storer's chub, *Erinemus storerianus* (Kirtland) | .. | 31 |
| (5) Black-nosed dace, *Rhinichthys atronasus* (Mitchill) | 54 | .. |
| (6) Long-nosed dace, *R. cataractae* (Cuv. & Val.) | 41 | 10 |
| (7) Horned dace, *Semotilus atromaculatus* (Mitchill) | 40 | .. |
| (8) Pug-nosed minnow, *Opsopoeodus emiliae* Hay | .. | 10 |
| (9) Black-nosed shiner, *Notropis heterodon* (Cope) | .. | 8 |
| (10) Black-nosed minnow, *N. heterolepis* Eigenm. & Eigenm. | .. | 8 |
| (11) Minnow, *N. volucellus* (Cope) | .. | 14 |
| (12) Straw-colored minnow, *N. deliciosus stramineus* (Cope) | 3 | 9 |
| (13) Spot-tailed minnow, *N. hudsonius* (Clinton) | 11 | 83 |
| (14) Steel-colored minnow, *N. whipplii* (Girard) | 9 | 49 |
| (15) Lake shiner, *N. atherinoides* (Raf.) | 63 | 81 |
| (16) Rosy-faced minnow, *N. rubrifrons* (Cope) | .. | 1 |
| (17) Common shiner, *N. cornutus* (Mitchill) | 34 | 1 |
| (18) Red-fin shiner, *N. umbratilis* (Girard) | 13 | .. |
| (19) Silvery-jawed minnow, *Ericymba buccata* (Cope) | .. | 3 |
| (20) Golden shiner, *Notemigonus crysoleucas* (Mitchill) | 5 | 7 |
| (21) Blunt-nosed minnow, *Hyborhynchus notatus* (Raf.) | 3 | 10 |
| (22) Fat-head minnow, *Pimephales promelas* (Raf.) | 9 | 2 |
| (23) Stone roller, *Campostoma anomalum* (Raf.) | 14 | 2 |

The above table clearly indicates that comparisons between the hosts, i.e., species of fish, will be difficult since equal numbers of the same species of minnow were not collected from both ends of the lake. Yet some interesting comparisons should be possible in a family containing 672 specimens. It appears feasible to compare infections primarily by groups of parasites encountered.

Only two families of trematodes were encountered, Strigeidae and Allocreadiidae. The former were found more frequently than the latter and are represented by several genera and species compared with one species for the second family. This latter form was new and was described as *Lebouria cooperi* Hunter & Bangham (1932); it was encountered from a single species of minnow, *N. whipplii*, from the eastern end. From the opposite end *L. cooperi* was encountered in *E. storerianus, R. cataractae, O. emiliae, N. volucellus, N. deliciosus stramineus, N. hudsonius, N. whipplii, N. atherinoides, E. buccata* and *H. notatus*. This evidence clearly suggests that this species may be designated as a parasite of the Cyprinidae even though this, or a closely related species, was also encountered in the darters.

It is interesting to note that Strigeidae were found in many of the minnows from both ends of the lake. Nine of 16 different species carried encysted strigeid metacercariae from the east end while 13 of 19 species from the west end were infected. *Neascus vancleavei* from the liver and mesenteries proved to be particularly interesting as it is undoubtedly one of the most widely distributed parasites. One new strigeid, *Neascus rhinichthysi* W. S. Hunter (1933) was encountered in the flesh and under the scales of both species of *Rhinichthys*. This minute parasite appears to be confined to the members of this genus and has not been reported elsewhere. It is interesting that this parasite is closely allied to *Neascus bulboglossa* but differs from it in the presence of an acetabulum and other morphological features. It should be noted that many of the forms from the western end of the lake were identified to genus only.

Both *Bothriocephalus cuspidatus* Cooper (1917) and *Ligula intestinalis* (Linn.) were encountered in minnows from both ends of Lake Erie. In the case of both parasites the infection consisted of larval forms, the *B. cuspidatus* being found in the digestive tract while the *L. intestinalis* was of

course secured only from the coelom. The former species occurred in three *N. atherinoides* from either end; the latter was found in three species, *N. deliciosus stramineus, N. hudsonius* and *N. cornutus* from the eastern end of the lake and from *E. storerianus, O. emiliae, N. hudsonius, N. whipplii* and *H. notatus* at the western end. It should be noted here that more than half the 58 infected spot-tailed minnows carried *L. intestinalis.* This unusually high percentage may have been associated with the fact that these infected minnows were usually collected near colonies of terns which have been reported as definitive hosts by European workers. Such high percentage of infection with *L. intestinalis* has been previously reported, as Hunter & Hunter (1931) noted that 17 of 34 suckers from Lower Chateaugay Lake were infected with 1 to 7 of these parasites. In Adirondack waters *N. cornutus* and the common sucker are most frequently found to carry *Ligula* (Hunter unpublished data). *N. atherinoides* contained a probable new and as yet undescribed species of *Proteocephalus* represented by a single strobila. *Camallanus oxycephalus* Ward & Magath was the only nematode identified from the east end of the lake and this occurred but once in *R. cataractae.* The same parasite was found in the same host and also in *N. heterodon, N. hudsonius, N. whipplii, N. atherinoides* and *E. buccata. Rhabdochona cascadilla* Wigdor was found in three minnows, *N. volucellus, N. hudsonius* and *N. whipplii.*

Acanthocephala occurred but once and twice respectively from the east and west ends. Myxosporidia, however, appeared but twice from the eastern end compared with 5 from the western end. One leech, *Piscicola punctata,* was found upon a single specimen of *N. whipplii* from the western area.

### Ameiuridae (Siluridae).

A total of 75 members of the Ameiuridae were examined from both ends of Lake Erie, 7 species and 5 genera being represented. Four times as many fish came from the western end of the lake as the eastern end where 6 species were examined, contrasted with 3 from the eastern end.

Channel Catfish, *Ictalurus punctatus* (Raf.): Two of the seven fish from the east end were infected with *Corallobothrium fimbriatum* Essex while 15 of the 29 from the west end harbored this species. We found a 100% parasitization in this region, with 6 species of trematodes, 2 of cestodes, 3 of nematodes, 2 of Acanthocephala, 2 of copepods and Myxosporidia represented. The trematode, *Megalogonia ictaluri* Surber (1928) found in this fish, constitutes the first record of this species from the Great Lakes. Likewise the occurrence of *Acetodextra amiuri* Pearse (1924), is worthy of note. This parasite was reported by Pearse (1924a) from the swim bladders of "the yellow, black and speckled bullheads in Lake Pepin (Mississippi River); in the black and speckled bullheads in Lake Michigan." Our records indicate that the parasite occurred in the gonads of the channel catfish. Hunter (unpublished data) reports the ovary of a single bullhead, *Ameiurus nebulosus,* infected with this parasite when taken from a tributary of the Oswegatchie River system, while Van Cleave & Mueller (1934) record it from fish from Oneida Lake.

Common Bullhead, *Ameiurus nebulosus* (Le Sueur): This was the second species of this family to be taken at the eastern end of the lake and its seven representatives were all free from parasites. The one specimen from the western end, however, carried trematodes, cestodes, nematodes and Acanthocephala.

Lake Catfish, *Villarius lacustris* (Walbaum): One representative only of this species was examined and this from the eastern end. No parasites other than lymphocystis cysts were found.

Other Catfishes: The four species taken solely from the western area are the black bullhead, *Ameiurus melas* Raf., the yellow stone cat,

*Noturus flavus* Raf., the tadpole stone cat, *Schilbeodes gyrinus* (Mitchill) and the spotted stone cat, *Schilbeodes miurus* (Jordan). A fairly heavy infection with an interesting distribution is evident in the table.

It should be mentioned at this point that the Ohio Division of Conservation makes it a practice to plant undersized channel catfish, black and common bullheads in the various streams of Ohio when they are taken by commercial fishermen. This practice may lead to the building up of greater numbers of these forms in the rivers of Ohio but the practice is questionable from the viewpoint of the parasitologist since it may well mean the establishment of undesirable parasites in uninfected streams. In some cases this is very harmful as has been proved by the bass (*loc. cit.*).

### Umbridae.

Mud Minnow, *Umbra limi* (Kirtland): But a single species of this family, the mud minnow, was examined. No infection occurred in the three specimens secured from the east end of the lake while six of the nine from the west end were parasitized by an immature nematode of the genus *Spiroxys* which matures in turtles and snakes (Yorke & Maplestone, 1926). All of these infested mud minnows were secured from a small weedy marsh which contained many turtles. While no examination was made of these latter forms, the fact that the parasites were of genus *Spiroxys* suggests the probability of these carrying the adult of the stage reported in the fish.

### Esocidae.

The Pickerels, *Esox vermiculatus, E. lucius*: Too few individuals of this family were examined to give much idea of the degree of infestation. Five little pickerels, *Esox vermiculatus* Le Sueur, were examined from streams at the west end entering Sandusky Bay and only one was found to be parasitized. It carried two species of trematodes in the intestinal tract, *Azygia angusticauda* (Stafford, 1904) and *Centrovarium lobotes* (MacCallum, 1895); one cestode, *Proteocephalus pinguis* LaRue, 1911, and one nematode, *Spinitectus gracilis* Ward & Magath, 1917.

Of the eight specimens of northern pike, *Esox lucius* Linn., six were from eastern Lake Erie and two from the opposite end. All those taken from the eastern end and one from the western end were infested with *Proteocephalus pinguis* LaRue. Two from the eastern end carried *Neoechinorhynchus tenellus* (Van Cleave).

### Cyprinodontidae.

Top Minnow, *Fundulus diaphanus menona* Jordan & Copeland: Thirty-one top minnows present an interesting picture of the difference in regional distribution of the parasites in Lake Erie. Fourteen were taken from the eastern end and three, or 21.4% were infected, compared with 17 taken from the western end where 10, or 58.8%, were infected. In contrast to the almost equal distribution of the hosts examined, it should be noted that the percentage of infection is more than doubled at the western end and five classes of parasites are found in comparison with two from the east. The trematode, *Neascus vancleavi* (Agersborg), was present in fish from both localities.

All but one of the individuals examined from the western area were obtained from the shallow, "ponded" areas of East and West Harbors where many other species of fish were more heavily parasitized than those from more open waters. A large proportion of the infesting forms were larval stages.

PERCOPSIDAE.

TROUT PERCH, *Percopsis omisco-maycus* (Walbaum): This was the only representative of the family studied. Of the 53 examined, all but 7 were taken at the western end of the lake. *Neascus vancleavi* (Agersborg), *Crepidostomum isostomum* Hopkins, *Centrovarium lobotes* (MacCallum), *Triaenophorus* sp. and *Bothriocephalus cuspidatus* Cooper were found distributed among 5 of the 7 fish from the east end.

At the west end, a proportionately high percentage of infection was found, there being 44, or 95.7%, of 46 fish infested. *Tetracotyle diminuta* Hughes, *N. vancleavi* (Agersborg) and *C. isostomum* Hopkins represent the trematodes, while larval *Triaenophorus* sp., *Bothriocephalus claviceps* (Goeze) and *Proteocephalus pearsei* LaRue were the cestodes encountered. *Triaenophorus* sp. outnumbered the other two cestodes, being found in 16 fish compared with 4 and 6, respectively. Seventeen hosts harbored *Camallanus oxycephalus* Ward & Magath while one carried a few *Agamonema. Leptorhynchoides thecatus* (Linton) was found encysted in one host and Myxosporidia infected 6 beneath the skin and under opercula.

It is evident that this little species is the natural host of a relatively large number of parasites; not only were all but 4 of the 53 fish infected, but each showed a variety of different forms and some overlapping of infection. A number had moderately heavy infestations.

A word on the distribution of the immature *C. lobotes* encysted in the flesh of this host might well be interjected at this point. It is significant to note in this connection that Bangham (unpublished data) has never encountered this parasite in other Ohio lakes. MacCallum (1895), who first described this form, presumably secured his material from fish from Lake Erie and the Grand River, Ontario, although this is only mentioned as the source of his *Anallocreadium armatum* (MacCallum, 1895). Stafford (1904) reports *C. lobotes* from the stomachs of the northern pike, *Esox lucius* Linn., and the wall-eyed pike, *Stizostedion vitreum* Mitchill, secured from Montreal markets. Cooper (1915) found the species adult in the intestine of *Ambloplites rupestris* (Raf.) from the Go-Home Bay, Lake Huron, Ontario. Ward & Whipple (1918) list it from Ontario and Pearse (1924a) reports the same species from the intestine of *Notropis hudsonius* (DeWitt Clinton) in Lake Michigan. This parasite is reported in this paper from both ends of Lake Erie. Hunter (1930) and Hunter & Hunter (1931) report the experimental infection of the small-mouthed black bass, *Micropterus dolomieu* Lacépède, thus adding another definitive host. These authors also have encountered encysted metacercariae from the following species: the trout perch, *Percopsis omisco-maycus*, from Lake Erie and Champlain watersheds; the blunt-nosed minnow, *Hyborhynchus notatus*, from the Lake Champlain and St. Lawrence River watersheds; the straw-colored minnow, *Notropis deliciosus stramineus*, and Cayuga minnow, *Notropis bifrenatus*, from Lake Champlain; the common shiner, *Notropis cornutus*, and the black-nosed minnow, *Notropis heterolepis*, from the St. Lawrence River watershed. Van Cleave & Mueller (1934) report metacercariae from the trout perch and young or mature adults from the intestines of *P. flavescens*, *S. vitreum*, *M. dolomieu* and *A. natalis*.

SERRANIDAE.

WHITE BASS, *Lepibema chrysops* (Raf.): The only representative of this family examined from Lake Erie is the white bass, *Lepibema chrysops* (Raf.). Of the two specimens examined from the eastern portion of the lake but one was infested; this contained only individuals of a small trematode, *Allacanthochasmus varius* Van Cleave. All of 23 adults and 6 of 9 young from the west end of Lake Erie were infected. These carried four species of trematodes, three of cestodes, four of nematodes and one species of

encysted glochidium of a mollusc. *A. varius* Van Cleave was found in 16 of the adults. Another fluke belonging to the Gyrodactyloidea was found on the gills of nine. These forms are found on many species of fish and sometimes cause noticeable losses, especially in fish confined to hatcheries. In none of these fish were there ectoparasites abundant enough to cause apparent damage. Three species of cestodes were found, two of which were larvae. *Proteocephalus pearsei* LaRue, a small form, was abundant in the intestinal tracts of 11. Many adult *Bothriocephalus cuspidatus* Cooper were found in one fish while 7 others contained only larvae. Light infections of *P. ambloplitis* (Leidy) were noted in the mesenteries of 3 hosts. The only nematode found in quantity was *Camallanus oxycephalus* Ward & Magath; three other species were found in small numbers. Due to the unequal collections of this host, a fair regional comparison of their parasites cannot be made. However, the heavy infection at the west end thus far found would probably continue to exceed that of the opposite end.

### Percidae.

A total of 429 fish belonging to 14 species in this family was examined from both ends of the lake. The species examined were as follows: yellow perch, *Perca flavescens* (Mitchill); sauger, *Stizostedion canadense griseum* (DeKay); wall-eyed pike, *Stizostedion vitreum* (Mitchill); blue pike, *Stizostedion glaucum* Hubbs; black-sided darter, *Hadropterus maculatus* (Girard); log perch, *Percina caprodes* (Raf.); Copeland's darter, *Rheocrypta copelandi* Jordan; sand darter, *Ammocrypta pellucida* (Baird); Johnny darter, *Boleosoma nigrum* (Raf.); rainbow darter, *Poecilichthys coeruleus* Storer; Iowa darter, *Poecilichthys exilis* (Girard); fan-tailed darter, *Catonotus flabellaris* (Raf.); least darter, *Microperca punctulata* Putnam; green-sided darter, *Etheostoma blennoides* Raf.

Yellow Perch, *Perca flavescens* (Mitchill): Of the 69 adult yellow perch examined, 24 were taken from the eastern end of Lake Erie and 45 from the western end. Infestation was universally high as 20 and 40 were parasitized, respectively, from the eastern and western areas. Of the 59 young yellow perch collected, 44 and 15 were examined, being taken, respectively, from the eastern and western ends, and 25 and 13 of these carried parasitic infections. No significant difference occurred between the degree of infection at either end of the lake.

The infection by trematodes, however, was much heavier both in degree and variety of parasites in the fish taken from the west end of the lake. Only two, *Bunodera luciopercae* (O. F. Mueller) from the intestine and *Diplostomum scheuringi* (Hughes) from the aqueous humor of the eye, were encountered in fish from the eastern end and then only in 3 and 2 instances, respectively. In contrast to this is the opposite end where the fish carried 6 species of trematodes, namely: *Crepidostomum cooperi* Hopkins, *Cryptogonimus chyli* (Osborn), *Clinostomum marginatum* (Rud.), *Neascus* sp., *Microphallus opacus* (Ward) and *Leuceruthrus* sp. The first-named parasite was the most common, being present in 12 of the 45 examined, while the larval *Neascus* sp. occurred in 5 instances, *Cryptogonimus chyli* in two and each of the others in but a single host. Trematode infection in the young of the species is negligible, for no fluke infection occurred in those taken at the eastern end and but one of those from the western end carried a fluke, *Neascus* sp., in the flesh. It is significant to note that no trematodes appeared to be prevalent all over the lake, although it should be borne in mind that members of the species as a whole carried 9 and 15 species from the eastern and western areas.

Most of the cestodes carried by the yellow perch were larval forms. In the eastern area three species were found, these being *Bothriocephalus cuspidatus* (Cooper), *Proteocephalus pearsei* LaRue and *Proteocephalus*

*ambloplitis* (Leidy). In the western area 17 adult perch carried one or more of the species just named. In addition 11 had *Proteocephalus pearsei* LaRue and two encysted *Triaenophorus* sp. Evidence is accumulating which suggests the existence of a third species of *Triaenophorus* from North America. Only a single specimen of the adult was obtained and we did not feel it advisable to base a description upon this alone. With the exception of the latter form, the same species were carried by the young yellow perch. The small species of cestode *P. pearsei* appeared more often in these young fish, as would be expected from its life cycle (Bangham, 1925).

The nematode *Dichelyne cotylophora* Ward & Magath was the most common representative of this group of parasites, being taken in 13 and 22 instances from the adults of the eastern and western areas, respectively. No other species of nematode was found in the yellow perch of the eastern end while one of those at the opposite end carried *Camallanus oxycephalus* Ward & Magath and one had a *Philometra cylindracae* (Ward & Magath) in its body cavity. Acanthocephala, leeches and the ectoparasitic fungus *Saprolegnia,* were also present in a few instances.

SAUGER, *Stizostedion canadense griseum* (De Kay): All of 10 saugers from the eastern area of Lake Erie and all but one of 33 from the opposite end were infested. There were 4 species of parasites from the former and 9 from the latter fish and the degree of infestation was also heavier in specimens from the western area.

One species of trematode, *Centrovarium lobotes* (MacCallum), was found in this fish from both regions and in addition the saugers from the west end carried *Bucephalus pusillus* (Stafford) in 6 instances and in one an encysted *Neascus* sp. The cestode *Bothriocephalus cuspidatus* (Cooper) was the most common parasite in these fish from both areas. These small intestinal forms do not appear to cause marked damage to the host even when present in large numbers. The only other species of cestode found in the sauger from the eastern regions was *Bothriocephalus claviceps* (Goeze) while 6 from the opposite end carried larval cysts of *Triaenophorus* sp. and 2 were infested with *Proteocephalus stizostethi* Hunter & Bangham (1933).

The only nematode reported was *Camallanus oxycephalus* Ward & Magath (1917), which was recovered from 12 of the 33 saugers from the western area. Seven of the fish at the eastern end carried members of the ectoparasitic gill copepod *Ergasilis centrarchidarum* Wright while on the gills of 3 of those at the opposite end were found *Ergasilus caeruleus* Wilson. Fish from the latter region also carried an infection of Acanthocephala, Myxosporidia, Lymphocystis and glochidia.

WALL-EYED PIKE, *Stizostedion vitreum* (Mitchill): Nine of 10 adult wall-eyed pike from the eastern region and all but one of 48 from the opposite end carried parasites. In the former area there were 4 species of parasites represented and in the latter 16 species, showing the same increase already noted for those coming from the western portion of the lake.

*Neascus vancleavei* (Agersborg) was the only trematode found in the eastern wall-eyed pike while the following forms were taken from this species from the other region: *Neascus* sp., *Azygia angusticauda* (Stafford), *C. lobotes* and *B. pusillus,* the latter being the most common.

The fish from both areas carried large numbers of *B. cuspidatus.* In the western region certain of the wall-eyed pike also carried liver cysts of *Triaenophorus* sp. and *P. ambloplitis* while *P. stizostethi* occurred in the intestines of 13 of these fish.

Of the other species infesting the wall-eyed pike the same form of nematodes and of parasitic copepods found in the sauger were present and in addition a single species of Acanthocephala. Seven of the fish being discussed had a "warty" skin showing evidences of the Lymphocystis disease.

Fish showing such a condition are usually discarded by commercial fishermen even though the flesh is not involved. Certain workers, Woodcock (1904) and Awerinzew (1907, 1911), think the causal agents are the single cell-like inclusions within the cysts and believe that they belong to the subclass Neosporidia, while others hold that these cells are not the infective organisms and that the disease is due to a filterable virus. Dr. R. R. Hyde of Johns Hopkins University writes: "Lymphocystis, a disease of certain fishes, has been known in Europe for a long time. It was mentioned by Lowe in 1874 and by McIntosh in 1884. Sandermann in 1892 described the disease in some detail and advanced the theory that the peculiar cells which compose the tumor-like outgrowths were the eggs of parasites, a view upheld by Zschiesche in 1910. Woodcock in 1904 advanced the idea that the lymphocystic cells were parasitic protozoan which he described as *Lymphocystis johnstonii.* The idea was adhered to by Awerinzew in 1907. Weissenberg in 1914 stated that the disease is due to the intracellular location of a virus that could not be demonstrated microscopically. In 1921 he published an extensive treatise on the subject confirming his previous studies in regard to its etiology. While the filterability of this agent has not been definitely established, it is our opinion that it is to be classified with the filterable viruses." These cysts are usually confined to the lymph spaces of the skin, but in one or two fishes there were large masses of them about the heart. There is need for more research on this disease which affects the three species of pike perch.

Twelve of 15 young wall-eyed pike taken in seine hauls in the extreme western part of Lake Erie yielded the same parasites as the adults with the exception of *P. ambloplitis* and *S. gracilis* which were not in adults.

Blue Pike, *Stizostedion glaucum* Hubbs: The remaining species of pike perch, the blue pike, carried many of the same forms as the other two members of the genus. Nearly all from both regions carried the cestode *B. cuspidatus* and *P. stizostethi.* These were the only parasites encountered in 7 of 10 blue pike in the eastern region while all of 10 from the opposite end yielded 10 species of parasites. One of these, an adult *P. ambloplitis,* constitutes a new definitive host record for this species.

Ten species of darters were examined, but 3 forms were all that were examined for both areas, so these are the only ones that can be compared as to degree and numbers of species. These small fish are of economic importance only so far as they act as food for game and commercial fish and bear stages of parasites which thus find their way to the larger fish.

Log Perch, *Percina caprodes* (Raf.): Nine of 13 log perch from the eastern area and 20 of 32 from the opposite end were parasitized. The 3 species of larval forms found in the former were, *Neascus* sp., *B. cuspidatus* and *Leptorhynchoides thecatus* (Linton) while in the western region 12 species of parasites were taken. *B. cuspidatus* was not found in the log perch from the latter area but the other 2 species were present and in addition the following: *Allocreadium boleosomi,* (Pearse), unidentified Strigeidae, *P. pearsei, P. stizostethi, C. oxycephalus, Agamonema* sp., *P. punctata,* and myxosporidian cysts. We thus see that these fish carry a number of forms which could infest other fish if taken as food.

Greeley & Bishop (1932) say concerning this fish, "The log perch is often used as a bait fish for black bass and is also a common food item of this and other game fishes." According to unpublished data of Wickliff, these fish are very widely distributed in western Lake Erie, 383 specimens of log perch being taken at 34 of the 37 stations visited on the seining trip from September 7 to 18, 1928.

Johnny Darter, *Boleosoma nigrum* (Raf.): Two of 7 Johnny darters from the eastern region carried the following forms: *C. marginatum, Neascus* sp. and *Proteocephalus* sp., while 13 of 16 from the opposite area yielded *Leuceruthrus* sp., *Neascus vancleavei* and *Agamonema* sp.

Fan-tailed Darter, *Catonotus flabellaris* (Raf.): The fan-tailed darter from the eastern portion of Lake Erie carried encysted *Neascus* sp., *C. marginatum* and *Tetracotyle communis* (Hughes) while the only forms encountered from those at the opposite end were *Neascus* sp. in the mesenteries and *L. thecatus* in the intestine of one.

Of the remainder of the darters examined from the western area, none showed a large number of parasites. Four least darters, *Microperca punctulata* Putnam were clean. Three of 10 green-sided darters, *Etheostoma blennoides* Raf., harbored unidentified Strigeidae, Allocreadiidae, and Myxosporidia. Of 7 Iowa darters, *Poecilichthys coeruleus* Storer, 4 carried Allocreadiidae, Strigeidae, larval *B. cuspidatus* and *L. thecatus*, respectively, and 5 had larval nematodes. Nine of 15 sand darters, *Ammocrypta pellucida* (Baird), were infested: one with a fluke tentatively identified as *Lebouria cooperi* (see discussion in Hunter & Bangham, 1932); another with several *Neascus* sp. in the liver; three with unidentified encysted Strigeidae; three with *C. oxycephalus* and 6 with unidentified nematodes. Only 8 of 34 Copeland's darters, *Rheocrypta copelandi* (Jordan), carried parasites; these being *Neascus* sp., *L. cooperi*, *B. cuspidatus* and *Camallanus* sp. One of 2 black-sided darters, *Hadropterus maculatus* (Girard), had a specimen of *C. oxycephalus* in its intestinal tract.

### Centrarchidae.

A total of 395 fish of this family from 8 genera and 9 species were examined for parasites during the course of these studies. These were small-mouthed black bass, *Micropterus dolomieu* Lacépède; large-mouthed black bass, *Aplites salmoides* (Lacépède); green sunfish, *Apomotis cyanellus* (Raf.); blue gill, *Helioperca incisor* (Cuvier & Valenciennes); pumpkinseed sunfish, *Eupomotis gibbosus* (Linn.); rock bass, *Ambloplites rupestris* (Raf.); white crappie, *Pomoxis annularis* Raf.; calico bass, *Pomoxis sparoides* (Lacépède); long-eared sunfish, *Xenotis megalotis* (Raf.).

In this group, which included many important game fish, 113 were examined from the eastern area and 282 from the western area and of these fish 67, or 59.2% and 234, or 82.9%, respectively, were infected. The data from this group bear out the previously noted heavier infestation of fish in the western region. As will be shown when comparing parasites of the same species at the opposite ends of Lake Erie, there were more forms in the western region and the degree of infestation was usually higher.

Small-mouthed Black Bass, *Micropterus dolomieu* Lacépède: Of the 57 adult small-mouthed black bass examined, 28 were taken from the eastern area and 29 from the opposite end. Infection was very high, as 24 and 28 respectively, were parasitized. Of the 64 young small-mouthed bass collected, 13 and 51 were examined, taken respectively from the eastern and western ends and 7 and 48 of these were infested.

Three species of trematodes were found in the adult bass from the eastern area: *Crepidostomum cornutum* (Osborn), *Centrovarium lobotes* (MacCallum), *Cryptogonimus chyli* Osborn, the first-named species being the most common. In contrast to this is the western end where the fish carried 5 species; in addition to the 3 forms already noted there were *Leuceruthrus micropteri* Marshall & Gilbert and *Gyrodactyloidea*, the latter forms being taken from the gills of one bass. In the young bass of the eastern area *C. cornutum* was recovered from 2 fish while in the young bass from the opposite region, in addition to the forms above named, 7 other species were taken as follows: *C. chyli*, *Gyrodactyloidea*, *Clinostomum marginatum*, (Rud.), *Microphallus opacus* Ward, *Neochasmus umbellus* Van Cleave & Mueller, *Azygia angusticauda* (Stafford) and *Bucephalus papillosus* Woodhead. Only the first two species were very abundant; none appeared to cause great harm to the host.

Only one species of cestode, *Proteocephalus ambloplitis* (Leidy), was obtained from 13 adult and 5 young small-mouthed bass from the eastern area, while from the opposite end this form appeared in 21 of 29 adult and 23 young bass. In addition, adult bass carried larval *Triaenophorus* sp., *Bothriocephalus claviceps* (Goeze) and *Proteocephalus pearsei* LaRue in 1, 1 and 3 instances, respectively. Of the 48 infected young bass from this area 21 had *P. pearsei* in their intestinal tracts.

Nematodes were not found to infest the small-mouthed bass very heavily from either end of Lake Erie. In the eastern area there were 3 species present: *Spinitectus carolini* Holl, *Dichelyne cotylophora* Ward & Magath and *Agamonema* sp. in 9, 3 and 6 cases, respectively, while at the opposite end the first-named form was found in 3 instances and *Camallanus oxycephalus* in two adults. Almost the same type of nematode infestation was found in the young bass. One species of Acanthocephala, *Leptorhynchoides thecatus* (Linton), was encountered very frequently in each area. This form with larvae and adults of the cestode *P. ambloplitis* were parasites taken most often and in greatest numbers. Young small-mouthed bass rarely carried this form. Another Acanthocephala, *Neoechinorhynchus cylindratus* (Van Cleave), was taken from bass in 1 and 3 cases from the eastern and western areas, respectively.

Other parasites not already mentioned from small-mouthed bass in the eastern area were the ectoparasitic copepods *Ergasilus centrarchidarum* Wright taken from gills of 5 fish, and *Achtheres ambloplitis* Kellicott from the gills of one. In addition the other region yielded two other species of copepods, two protozoa, one leech, and the fungus *Saprolegnia parasitica.*

LARGE-MOUTHED BLACK BASS, *Aplites salmoides* (Lacépède): No comparison can be made regarding the parasitism of the large-mouthed bass in the two regions as but 3 adults and no young were examined in the eastern area while 24 adults and 105 young were examined in the opposite region. *Crepidostomum cornutum* (Osborn) and *Spinitectus carolini* Holl were the only parasites of the 5 species found in the eastern large-mouthed bass which were not also found in this species of bass from the opposite end.

Twenty of the adults and 87 of the young from the western area carried parasites. Fewer species of trematodes were taken than from the small-mouthed bass. The following flukes were secured from 4, 4, and 3 of the adults, respectively: *Leuceruthrus micropteri* Marshall & Gilbert, *Cryptogonimus chyli* Osborn and Gyrodactyloidea. The same species of parasites in the same order were secured from 18, 10 and 10 of the young bass; 4 also had liver cysts of the larval fluke *Neascus vancleavei* (Agersborg).

Six and 3 of the young and adult large-mouthed black bass were infected, respectively, with *P. pearsei* while 37 and 10, respectively, carried *P. ambloplitis.* Adults of this species occurred in the intestinal tract while plerocercoids were encysted in the liver, spleen, mesenteries and gonads. Among the persons who have reported the damage to the host caused by this larval form are Riley, (1919), Rich (1923), Bangham (1925, 1928a and 1934), Moore (1926), Hunter (1928) and Hunter & Hunter (1930 and 1931).

The degree of infestation for this form was quite heavy both in the small-and large-mouthed black bass examined from the western area of Lake Erie. Certain adult bass had from 5 to 8 of these large cestodes in their intestinal tracts and large numbers of the plerocercoids encysted in their viscera. In certain fish the infestation by the larvae was so heavy and so much scar tissue was present in their reproductive organs that there was apparently no spawning. Many states formerly secured their hatchery breeding stock of small-and large-mouthed black bass from Lake Erie but this practice has been largely discontinued because so many of these fish prove to be poor breeders, many becoming sterilized through the

activity of the parasite. Records of the Ohio Conservation Division show that since 1881 bass have been transported from Lake Erie to streams and lakes within the state. This form has been found in black bass from all lakes in Ohio where these fish were examined but fortunately this species is almost entirely confined to lake bass, Hunter & Hunter (1931). Stream bass usually carry another species, *Proteocephalus fluviatilis* Bangham, which has no encysted stage in the fish.

In one or two fish in each instance the following nematodes were found in the western large-mouthed bass: *Contracaecum brachyurum* (Ward & Magath), *Camallanus oxycephalus* Ward & Magath, *Dichelyne cotylophora* Ward & Magath, *Dioctophyme* sp. and *Agamonema* sp. The same two species of Acanthocephala that appeared in the small-mouthed bass were taken but *N. cylindratus* was more frequent and abundant. Of the other parasites the same species as those encountered in the small-mouthed bass were found with the addition of two more protozoan forms. One of the latter was encysted on the gill filaments of 25 of the young fish and belonged to the Myxosporidia. It is interesting that this fish, which is not very abundant in Lake Erie, harbors so many different species of parasites.

COMMON SUNFISH, *Eupomotis gibbosus* (Linn.): Common sunfish from both areas were examined; 12 of 18 from the eastern portion and 19 of 23 from the opposite end were infested. One to 4 of the fish from the eastern area carried the following species of parasites: *Allocreadium* sp., *Crassiphiala ambloplitis* (Hughes), *Neascus vancleavei, Bothriocephalus* sp., *P. ambloplitis, S. carolini* Holl, *Agamonema* sp., *L. thecatus,* while this host from the opposite end sheltered from 1 to 7 of the same parasites per fish and in addition larval *C. marginatum* in the flesh of one, *C. oxycephalus* in one, Myxosporidia on the gills of 3 and the leech, *P. punctata* on one.

ROCK BASS, *Ambloplites rupestris* (Raf.): In the eastern area 21 of 28 and in the other area 11 of 12 rock bass were parasitized with 8 and 14 species, respectively. The parasites common to both areas were *C. chyli,* metacercariae of *Crassiphiala ambloplitis* (Hughes), *P. ambloplitis, S. carolini* Holl, *L. thecatus, E. centrarchidarum.* Only two forms were recovered from rock bass in the eastern portion of Lake Erie, these being *L. micropteri* and *P. pearsei* while the following were taken in the opposite end: *C. ambloplitis* Hopkins (1931), metacercariae of *C. marginatum* and *N. vancleavei, B. claviceps, Rhabdochona* sp., *Contracaecum* sp., *Agamonema* sp., *C. oxycephalus* and *Achteres ambloplitis* Kellicott. In most cases the infestation with one of the above species in either area was limited to 1 to 5 fish, the exception being in the eastern area when 6 and 7 rock bass carried *L. micropteri* and *C. ambloplitis,* respectively.

WHITE CRAPPIE, *Pomoxis annularis* Raf: A single nematode, *S. gracilis,* was the only parasite found in the examination of 8 white crappies from the eastern area, while 8 of 17 from the other portion of the lake yielded the following forms in from 1 to 5 fish: *C. oxycephalus, Agamonema* sp., *L. thecatus, E. centrarchidarum* and an encysted myxosporidian form.

CALICO BASS, *Pomoxis sparoides* Lacépède, AND LONG-EARED SUNFISH, *Xenotis megalotis* (Raf.): Calico bass were not heavily infested. These fish were examined only in the western area and but three species of parasites were present in small numbers. The single long-eared sunfish taken in this area yielded only cysts of *N. vancleavei.*

Our data just discussed show a very wide distribution of many of the parasites both as to general dispersal over Lake Erie and the presence of the same species in many forms belonging to the family Centrarchidae. With the exceptions already noted, there is but slight evidence that these forms cause marked damage to the host unless crowded, as under hatchery conditions.

ATHERINIDAE.

BROOK SILVERSIDES, *Labidesthes sicculus* (Cope): The brook silversides was the only representative of this family examined. Fifteen of these slender, graceful fish were taken from the east end of the lake and all were free from parasites. Of the 30 from the west end, 10 carried light infections. Adult *Camallanus oxycephalus* Ward & Magath were found in a single instance. All other parasites encountered were sexually immature; *Neascus* sp., *Allacanthochasmus varius* Van Cleave, *P. ambloplitis* (Leidy) and some *Agamonema* were encysted in liver and mesenteries, while *Allocreadium* sp., *Bothriocephalus* sp. and other *Agamonema* were found in the alimentary canal.

This fish usually lives but one season (Hubbs, 1921; Cahn 1927). It is therefore interesting that so many parasites have adapted themselves to this short-lived form; the presence of so many immature parasites suggests that *L. sicculus* may prove to be either an accidental host or an intermediate host for at least four species.

SCIAENIDAE.

SHEEPSHEAD OR FRESH-WATER DRUM, *Aplodinotus grunniens* Rafinesque: This is the only representative of this family to be recorded from Lake Erie. A total of 48 individuals was examined and showed an unusually high degree of infestation since all but four carried parasites of one sort or another. Furthermore, this species sheltered an unusually diversified list of parasites, some of which are remarkably interesting. A regional infestation comparison is again impractical as only three specimens were taken from the eastern end. However, all of these three were infected.

*Anallocreadium armatum* (MacCallum) was the only trematode encountered in the fish from the eastern end; none of these were obtained from the western end, but 10 fish carried a new fluke of the same genus, *Anallocreadium pearsei* Hunter & Bangham (1932). Other new trematodes were discovered as ectoparasites of 5 of the fish from the western end of the lake. These were identified as *Microcotyle spinicirrus* (MacCallum) and *M. eriensis* and were described by Bangham & Hunter (1936).

No other unusual forms were met; three other flukes were found, two Strigeidae and one *Crepidostomum*. Two cestodes, both sexually immature, were taken and four species of nematodes, as well as some *Agamonema*. It should be noted that three of these nematodes, *Camallanus oxycephalus*, *Dichelyne cotylophora* and *Spinitectus gracilis*, were often found in the intestines of the Esocidae, Percidae and Centrarchidae. Acanthocephala, Myxosporidia, leeches and glochidia were also present in considerable quantity.

COTTIDAE.

MILLER'S THUMB, *Cottus bairdii* Girard: Seven specimens of miller's thumb or sculpin, *Cottus bairdii* Girard, were examined from about the Bass Islands and inlets of cold streams of the west end of the lake. Only two of these were infected with parasites and then with a single larva. One carried a cyst of a larval *Proteocephalus ambloplitis* (Leidy) in the liver and the other a young plerocercoid of *Proteocephalus* sp. in the alimentary canal. It had five well-developed suckers and may belong to an undescribed species.

GASTEROSTEIDAE.

BROOK STICKLEBACK, *Eucalia inconstans* (Kirtland): Comparisons of the infection of the brook stickleback, *Eucalia inconstans* (Kirtland), are

not significant as nearly all of the forms were taken at the east end of the lake. The most interesting parasite encountered was *Bunoderina eucaliae* Miller, 1936, from the intestine. This small trematode is apparently widely distributed, for it has been found not only in the Lake Erie watershed, but also in the Lake Champlain and St. Lawrence River watersheds (Hunter unpublished data). It occurs typically in fish from warm, shallow, weedy, marshy areas. The percentage of infection of this host in the Lake Erie watershed is very low; only 3 of 22 fish were parasitized and these with light infections.

### Gadidae.

Burbot or Ling, *Lota maculosa* (Le Sueur): The burbot, *Lota maculosa* (Le Sueur), is the only representative of this family examined. A total of 10 fish taken from gill nets in the deeper parts of the lake yielded a 100% infection with *Abothrium crassum* (Bloch); adults were often numerous in pyloric caeca and the rest of the digestive tract. In five cases the larvae were encysted in the stomach wall giving it a rough, warty appearance. The roundworm, *Haplonema hamulatum* Moulton, was found in two specimens from the east end. These three hosts also harbored Acanthocephala belonging to the species *Echinorhynchus coregoni* Linkins.

The ectoparasitic leech, *Piscicola punctata* (Verrill), was found in moderate numbers upon three of the seven hosts examined from the western end. Many other burbots, not examined for internal parasites, were found to be infected with one to 10 of these leeches.

## Section IV. Parasites Occurring in More Than One Host.

Forty-nine species of parasites were found in but a single host species of fish from Lake Erie. Several forms were identified only to family or genus and several species may be represented in these groups. In most cases the same parasites are found in closely related fishes but a few parasitic forms are widely distributed throughout many fish. Those parasites followed by the letter "E", are from fish obtained in the eastern area and those by "W", from the western area of Lake Erie.

Trematodes. *Allacanthochasmus varius* Van Cleave. This trematode was common in the intestines of white bass (E & W), and an encysted larva of this species was found in a brook silversides (W).

Allocreadiidae. Unidentified trematodes belonging to this family were taken from the intestines of silvery-jawed minnow (W), brook silversides (W), pumpkinseed (E) and lake sturgeon (W).

*Bucephalus pusillus* (Stafford). These small trematodes were found in the stomach and pyloric caeca of blue pike (W), sauger (W) and wall-eyed pike (W).

*Centrovarium lobotes* (MacCallum). In the intestine and pyloric caeca of trout perch (E), little pickerel (W), sauger (E & W), wall-eyed pike (W), blue pike (W) and small-mouthed black bass (E & W). Metacercariae of this species were reported from the trout perch in Cattaraugus Creek while the following species from other parts of New York were reported to harbor these encysted stages: blunt-nosed minnow (*H. notatus*), straw-colored minnow (*N. deliciosus stramineus*), Cayuga minnow (*N. bifrenatus*), common shiner (*N. cornutus frontalis*) and the black-nosed minnow (*N. heterolepis*) (Hunter & Hunter, 1931).

*Clinostomum marginatum* (Rud.). This larval form was present encysted in the flesh of black bullhead (W), Johnny darter (E), log perch (W), fan-tailed darter (E), small-mouthed black bass (W), blue gill (W), pumpkinseed (W) and rock bass (W).

*Crepidostomum cornutum* (Osborn). This was found in the intestine and stomach of black bullhead (W), bowfin (W), small-mouthed black bass (E & W), large-mouthed black bass (E) and rock bass (E & W).

*Cryptogonimus chyli* Osborn. This small form was found chiefly in the pyloric caeca of the yellow perch (E), small-mouthed black bass (E & W), large-mouthed black bass (W) and rock bass (W).

Gyrodactyloidea. Species belonging to this group were often found on the gills of white bass (W), channel catfish (W), small-mouthed black bass (W), large-mouthed black bass (W) and blue gill (W). Because of the large numbers of new species now being named and the lack of living material, identification of the species in this superfamily was not attempted.

*Lebouria cooperi* Hunter & Bangham. This species was characteristically found in the intestine of the following minnows: *Notropis volucellus* (W), spot-tailed minnow (W), lake shiner (W), steel-colored minnow (E & W), long-nosed dace (W), Storer's chub (W) and pug-nosed minnow (W). The same or a related species was also found in the Iowa darter (W), Copeland's darter (W) and sand darter (W).

*Leuceruthrus micropteri* Marshall & Gilbert. Adults belonging to this species were obtained from the stomach of bowfin (W), black bull-head (W), rock bass (E), small-mouthed black bass (W) and large-mouthed black bass (W). Unidentified larval forms belonging to this genus were found in the intestinal tracts of white bass (W), moon-eye (W), yellow perch (W), log perch (W) and Johnny darter (W).

*Megalogonia ictaluri* Surber. These small intestinal trematodes were present in the channel catfish (W), black bullhead (W), spotted stone catfish (W) and yellow stone catfish (W).

*Microphallus opacus* Ward. This species occurred in the bowfin (W), yellow perch (W) and small-mouthed black bass (W).

*Neascus rhinichthysi* W. S. Hunter. These cysts occurred in black-nosed dace (E) and long-nosed dace (E).

*Neascus vancleavei* (Agersborg). These larval forms were encysted in the liver and mesenteries of trout perch (E & W), Menona top minnow (E & W), black-nosed dace (E), horned dace (E), *Nocomis micropogon* (E), spot-tailed minnow (E & W), common shiner (E), stone roller (E), *Notropis volucellus* (W), lake shiner (W), blunt-nosed minnow (W), Johnny darter (W), wall-eyed pike (E), pumpkinseed (E & W), large-mouthed black bass (W), blue gill (W), rock bass (W), calico bass (W) and long-eared sunfish (W).

Other metacercariae of the *Neascus* group were identified in German carp (W), Storer's chub (W), pug-nosed minnow (W), black-nosed shiner (W), straw-colored minnow (W), steel-colored minnow (W), fat-head minnow (W), pumpkinseed (E), Copeland's darter (W), sheepshead (W), white bass (W), tadpole catfish (W), *Nocomis micropogon* (E), common shiner (E), golden shiner (E), blunt-nosed minnow (E), stone roller (E), log-perch (E & W), Johnny darter (E), fan-tailed darter (E & W), yellow perch (W), sauger (W) and wall-eyed pike (W).

Other Strigeidae. Some cysts from the lake shiner (W), Storer's chub (W), log perch (W), sand-darter (W), Iowa darter (W) and green-sided darter were identified only to family.

*Tetracotyle* sp. Cysts of trematodes belonging to this group were found in moon-eye (W), spot-tailed minnow and blue gill (W). Unidentified trematodes were found in the stickleback (E) and Menona top minnow (E).

CESTODES. *Abothrium crassum* (Bloch). This species occurred free in the intestine as an adult in the burbot (E & W), white fish (E & W), and lake herring (W); the larval stage was also found encysted in the stomach of the burbot.

*Bothriocephalus claviceps* (Goeze). This species was occasionally found in the intestines of sheepshead (E), trout perch (W), sauger (E), small-mouthed black bass (W) and rock bass (W).

*Bothriocephalus cuspidatus* Cooper. Larval forms were obtained from the intestinal tracts of sheepshead (W), moon-eye (W), lake shiner (E & W), log perch (W), Copeland's darter (W), Iowa darter (W) and white bass (W). Adults were common in sauger (E & W), wall-eyed pike (E & W), blue pike (E & W) and yellow perch (E & W).

Immature forms identified only to genus were present in brook silversides (W), long-nosed gar and pumpkinseed (E), and a mature form from the tadpole catfish was identified only to genus.

*Corallobothrium fimbriatum* Essex. This was secured from the intestine of channel catfish (E & W), black bullhead (W), yellow stone catfish (W) and spotted catfish (W).

*Corallobothrium* n. sp. This small form was found in the intestine of black bullhead (W) and common bullhead (W).

*Ligula intestinalis* (Linn.). In certain regions many of the following fish carried these forms in their peritoneal cavities: common sucker (E & W), straw-colored minnow (E), common shiner (E), spot-tailed minnow (E & W), Storer's chub (W), pug-nosed minnow (W), steel-colored minnow (W) and blunt-nosed minnow (W).

*Proteocephalus ambloplitis* (Leidy). Cysts of the plerocercoids were present in miller's thumb (W), brook silversides (W), white bass (W), black bullhead (W), yellow stone catfish (W), long-nosed gar (W), lake shiner (W), spot-tailed minnow (W), yellow perch (E & W), wall-eyed pike (W), blue pike (W), blue gill (W), pumpkinseed (E & W), rock bass (E & W), bowfin (W), small-mouthed black bass (E & W) and large-mouthed black bass (E & W).

Intestinal forms were secured from long-nosed gar (W), bowfin (W), small-mouthed bass (E & W), large-mouthed black bass (W) and rock bass (W).

*Proteocephalus exiguus* Larue. This occurred in the intestines of whitefish (E & W) and lake herring (E & W).

*Protcocephalus fluviatilis* Bangham. This interesting parasite was found in the intestine of a pumpkinseed (E), as well as small-mouthed and large-mouthed bass from the streams emptying into Lake Erie; however none were obtained from these fish examined from Lake Erie.

*Proteocephalus pearsei* Larue. This species was especially common in the intestines of young sheepshead (W), white bass (W), trout perch (W), yellow perch (E & W), log perch (W), rock bass (E), small-mouthed black bass (W), large-mouthed black bass (W) and blue gill (W).

*Proteocephalus pinguis* Larue. Tapeworms belonging to this species were present in the intestine of northern pike (E & W), little pickerel (W), horned dace (E), lake shiner (E) and spot-tailed minnow (W). The specimens from the last three fish were sexually immature.

*Proteocephalus stizostethi* Hunter & Bangham. This was taken from the intestine of the blue pike (E & W), sauger (W) and wall-eyed pike (W).

Larval representatives of this genus were obtained from stickleback (W), miller's thumb (W), Menona top minnow (W), moon-eye (W), log perch (W), yellow perch (E) and Johnny darter (E). An adult of a new species was taken from the intestine of a lake shiner minnow (W).

*Triaenophorus* sp. Liver and visceral cysts were present in yellow perch, (W), sauger (W), wall-eyed pike (E & W), blue pike (W), small-mouthed black bass (W), and an adult was found in the intestine of the blue pike (W). Immature cysts of a different species were found in trout perch (W) and common sucker (E & W).

NEMATODES. *Agamonema* sp. Larval nematodes were obtained from the following fish: sheepshead (W), brook silversides (W), white bass (W), Menona top minnow (W), channel catfish (W), common bullhead (W), common sucker (W), gizzard shad (W), *Nocomis micropogon* (E), horned dace (E), steel-colored minnow (E & W), German carp (W), goldfish (W), pug-nosed minnow (W), spot-tailed minnow (W), golden shiner (W), yellow perch (W), wall-eyed pike (W), log perch (W), sand darter (W), Johnny darter (W), Iowa darter (W), small-mouthed black bass (E & W), large-mouthed black bass (W), blue gill (E), pumpkinseed (W), rock bass (W) and white crappie (W).

*Camallanus oxycephalus* Ward & Magath. This was the most common and widely distributed species of nematode, especially in the western area. This red form was found near the posterior of the intestinal tract in sheepshead (W), brook silversides (W), white bass (W), trout perch (W), channel catfish (W), yellow stone catfish (W), moon-eye (E & W), long-nosed dace (E & W), black-nosed shiner (W), spot-tailed minnow (W), steel-colored minnow (W), lake shiner (W), silvery-jawed minnow (W), yellow perch (W), sauger (W), wall-eyed pike (W), black-sided darter (W), log perch (W), Copeland's darter (W), sand darter (W), green-sided darter (W), small-mouthed black bass (W), large-mouthed black bass (W), blue gill (W), pumpkinseed (W), rock bass (W), calico bass (W) and white crappie (W).

*Cystidicola stigmatura* (Leidy). This was found in the air bladder of lake herring (W) and whitefish (W). It is one of the more unusual nematodes.

*Dichelyne cotylophora* (Ward & Magath). This form was present in the intestine of sheepshead (E & W), white bass (W), black bullhead (W), wall-eyed pike (W), small-mouthed black bass (E), large-mouthed black bass (W), blue gill (W) and yellow perch (E & W). It was most often found in the last-named fish.

*Philometra cylindracea* (Ward & Magath). This species was encysted in the peritoneum of sheepshead (W), yellow perch (W) and blue pike (W).

*Rhabdochona cascadilla* Wigdor. This parasite appeared in the intestine of the common red horse (E), moon-eye (E & W), *Moxostoma lesueurii* (W), *Notropis volucellus* (W), spot-tailed minnow (W), steel-colored minnow (W) and rock bass (W).

Other Rhabdochona which were not identical with the above species were present in white bass (W), Menona top minnow (W) and blue gill (W).

*Spinitectus gracilis* Ward & Magath. These intestinal nematodes were recovered from sheepshead (E & W), northern pike (W), channel catfish (W), yellow stone catfish (W), wall-eyed pike (W) and white crappie (E).

*Spinitectus carolini* Holl. These small nematodes were secured from the intestinal tracts of small-mouthed black bass (E & W), large-mouthed black bass (E), pumpkinseed (E & W) and rock bass (E).

ACANTHOCEPHALA. *Echinorhynchus* sp. Larval and adult forms belonging to this genus were carried by white fish (W), wall-eyed pike (W), blue pike (W), log perch (W) and Iowa darter (W).

*Leptorhynchoides thecatus* (Linton). This form was found as an immature specimen encysted in the mesenteries of trout perch (W), channel catfish (W), black bullhead (W), fan-tailed darter (E), calico bass (W), and common as a mature individual attached to the inner wall of the intestine in sheepshead (W), yellow stone catfish (W), bowfin (W), long-nosed gar (W), Storer's chub (W), log perch (E & W), yellow perch (W), small-mouthed black bass (E & W), pumpkinseed (E & W), rock bass (E & W), blue gill (W), large-mouthed black bass (W) and white crappie (W).

*Neochinorhynchus cylindratus* (Van Cleave). This parasite appeared

in the intestine of wall-eyed pike (E), small-mouthed black bass (E & W) and large-mouthed black bass (E & W).

Members of the genus were present in the Menona top minnow (W) and sauger (W).

LEECHES. *Piscicola punctata* (Verrill). This interesting ectoparasite occurred on burbot (W), sheepshead (W), black bullhead (W), steel-colored minnow (W), yellow perch (W), wall-eyed pike (W), log perch (W), small-mouthed black bass (W), blue gill (W) and pumpkinseed (W).

PROTOZOA. *Ichthyophthirius multifiliis* Fouquet. Small skin cysts of this form were present on large-and small-mouthed black bass (W).

*Lymphocystis* sp. A form belonging to this genus was found on big catfish (E), sauger (W), wall-eyed pike (W) and blue pike (W).

MYXOSPORIDIA. Gill cysts occupied by representatives of this order were taken from sheepshead (W), channel catfish (W), red horse (W), lake shiner (W), straw-colored minnow (W), golden shiner (W), large-and small-mouthed black bass (W), pumpkinseed (W), white crappie (W), and flesh of visceral cysts of this order from fat-head minnow (E), blunt-nosed minnow (W), sauger (W), log perch (W) and hog sucker (W).

COPEPODS. *Achtheres micropteri* Wright. This parasitic crustacean was found on the gills of the large-and small-mouthed black bass (W).

*Achtheres pimelodi* Krøyer. Members of this species occurred on the gills of the channel catfish (W) and common bullhead (W).

*Ergasilus caeruleus* Wilson. This was taken from the gills of sauger (W), wall-eyed pike (W) and blue pike (W).

*Ergasilus centrarchidarum* Wright. This ectoparasite was attached to the gills of the sauger (E), wall-eyed pike (W), small-mouthed black bass (E & W), large-mouthed black bass (E & W), blue gill (W) and rock bass (W).

*Ergasilus versicolor* Wilson. This was found on the gills of channel catfish (W) and yellow stone catfish (W).

FUNGUS. *Saprolegnia parasitica.* Fish were more often taken with this fungus on their bodies in the spring. The following fish which were examined had this form: yellow perch (E), green-sided darter (W), small-mouthed black bass (W) and large-mouthed black bass (W).

MOLLUSCS. Glochidia were found only on the gills of the following fish: sheepshead (2 species, W), white bass (W), sauger (W), blue gill (W), calico bass (W). Most of the infested fish were taken from Lake Erie near the mouth of the Detroit River.

## SECTION V. CHECK LIST OF FISH PARASITES FROM LAKE ERIE.

### TREMATODA.

*Acetodextra amiuri* (Stafford, 1900)
*Allacanthochasmus varius* Van Cleave, 1922
*Allocreadium armatum* (MacCallum, 1895)
*Allocreadium boleosomi* Pearse, 1924
*Allocreadium* sp. 4 species
*Alloglossidium corti* (Lamont, 1921)
*Anallocreadium pearsei* Hunter & Bangham, 1932
*Azygia angusticauda* (Stafford, 1904)
*Azygia* sp.
*Bucephalus papillosus* Woodhead, 1929
*Bucephalus pusillus* (Stafford, 1904)
*Bunodera luciopercae* (O. F. Mueller, 1776)
*Bunoderina eucaliae* Miller, 1936
*Centrovarium lobotes* (MacCallum, 1895)
*Clinostomum marginatum* (Rud., 1819)

*Crassiphiala ambloplitis* (Hughes, 1927)
*Crepidostomum cooperi* Hopkins, 1931
*Crepidostomum cornutum* (Osborn, 1903)
*Crepidostomum isostomum* Hopkins, 1931
*Crepidostomum illinoiense* Faust, 1918
*Crepidostomum lintoni* (Pratt in Linton, 1901)
*Cryptogonimus chyli* Osborn, 1903
*Diplostomum scheuringi* Hughes, 1929
*Lebouria cooperi* Hunter & Bangham, 1932
*Leuceruthrus micropteri* Marshall & Gilbert, 1905
*Leuceruthrus* sp.
*Macroderoides spiniferus* Pearse, 1924
*Macroderoides typicum* (Winfield, 1929)
*Megalogonia ictaluri* Surber, 1928
*Microcotyle eriensis* Bangham & Hunter, 1936
*Microcotyle spinicirrus* MacCallum, 1918
*Microphallus opacus* (Ward, 1894)
*Neascus bulboglossa* (Van Haitsma, 1925)
*Neascus rhinichthysi* W. S. Hunter, 1933
*Neascus vancleavei* (Agersborg, 1926)
*Neascus wardi* W. S. Hunter, 1928
*Neascus* sp. 3 species
*Neochasmus umbellus* Van Cleave & Mueller, 1932
*Phyllodistomum superbum* Stafford, 1904
*Tetracotyle communis* Hughes, 1928
*Tetracotyle diminuta* Hughes, 1928
*Tetracotyle* sp.
*Vietosoma parvum* Van Cleave & Mueller, 1932

CESTODA.

*Abothrium crassum* (Bloch, 1779)
*Bothriocephalus claviceps* (Goeze, 1782)
*Bothriocephalus cuspidatus* Cooper, 1917
*Bothriocephalus* sp.
*Corallobothrium fimbriatum* Essex, 1928
*Corallobothrium giganteum* Essex, 1928
*Corallobothrium* n. sp.
*Cyathocephalus americanus* Cooper, 1917
*Haplobothrium globuliforme* Cooper, 1914
*Ligula intestinalis* (Linn., 1758)
*Proteocephalus ambloplitis* (Leidy, 1887)
*Proteocephalus exiguus* LaRue, 1919
*Proteocephalus fluviatilis* Bangham, 1925
*Proteocephalus pearsei* LaRue, 1919
*Proteocephalus pinguis* LaRue, 1911
*Proteocephalus singularis* LaRue, 1911
*Proteocephalus stizostethi* Hunter & Bangham, 1933
*Proteocephalus wickliffi* Hunter & Bangham, 1933
*Proteocephalus* sp.
*Schistocephalus* sp.
*Triaenophorus nodulosus* (Pallas, 1781)
*Triaenophorus* sp.

CESTODARIA.

*Glaridacris catostomi* Cooper, 1920
*Hypocaryophyllaeus paratarius* Hunter, 1927

NEMATODA.

*Agamonema* sp.
*Camallanus oxycephalus* Ward & Magath, 1917
*Contracaecum* sp.
*Contracaecum brachyurum* (Ward & Magath, 1917)
*Cucullanus clitellarius* Ward & Magath, 1917

*Cystidicola lepisostei* Hunter & Bangham, 1933
*Cystidicola stigmatura* (Leidy, 1886)
*Cystidicoloides harwoodi* (Chandler, 1931)
*Dichelyne cotylophora* (Ward & Magath, 1917)
*Dioctophyme* sp.
*Haplonema hamulatum* Moulton, 1931
*Haplonema immutatum* Ward & Magath, 1917
*Philometra cylindracea* (Ward & Magath, 1917)
*Rhabdochona cascadilla* Wigdor, 1918
*Rhabdochona* sp.
*Spinitectus carolini* Holl, 1928
*Spinitectus gracilis* Ward & Magath, 1917
*Spiroxys* sp.

ACANTHOCEPHALA.

*Echinorhynchus coregoni* Linkins (in Van Cleave, 1919)
*Echinorhynchus* sp.
*Leptorhynchoides thecatus* (Linton, 1891)
*Neoechinorhynchus crassus* Van Cleave, 1919
*Neoechinorhynchus cylindratus* (Van Cleave, 1913)
*Neoechinorhynchus tenellus* (Van Cleave, 1913)
*Neoechinorhynchus* sp.
*Octospinifer macilentus* Van Cleave, 1919
*Pomphorhynchus bulbocolli* Linkins (in Van Cleave, 1919)
*Pomphorhynchus* sp.

PROTOZOA.

*Cyclochaeta domerguei* Wallengren, 1897
*Ichthyophthirius multifiliis* Fouquet, 1876
*Lymphocystis johnstonei* Woodcock, 1904
Myxosporidia
Vorticellidae

COPEPODA.

*Achtheres ambloplitis* Kellicott, 1880
*Achtheres micropteri* Wright, 1882
*Achtheres pimelodi* Krøyer, 1863
*Argulus catostomi* Dana & Herrick, 1837
*Ergasilus caeruleus* Wilson, 1911
*Ergasilus centrarchidarum* Wright, 1882
*Ergasilus versicolor* Wilson, 1911
Lernaeidae

MOLLUSCA.

Glochidia

FUNGUS.

*Saprolegnia parasitica* Coker, 1923

HIRUDINEA.

*Piscicola punctata* (Verrill, 1872)
*Plaeobdella montifera* Moore, 1912

## SECTION VI. PARASITES OCCURRING IN ONE HOST OR OF RARE OCCURRENCE.

The check list which follows gives the parasites which were found in one host. These parasites were usually mature and as may be seen from the tables for parasites by families of fish were occasionally forms rare in fish of this lake. Many were restricted as to habitat. As in the previous list, "E" indicates the host secured from the eastern portion of Lake Erie and "W" following the host indicated the western area.

| Trematodes | Hosts | Region |
|---|---|---|
| *Acetodextra amiuri* | Channel catfish | W |
| *Allocreadium armatum* | Sheepshead | E |
| *Allocreadium boleosomi* | Log perch | W |
| *Anallocreadium pearsei* | Sheepshead | W |
| *Alloglossidium corti* | Tadpole cat | W |
| *Azygia angusticauda* | Blue pike | W |
| *Bunodera luciopercae* | Yellow perch | W |
| *Crassiphiala ambloplitis* | Rock bass | E & W |
| *Crepidostomum cooperi* | Yellow perch | W |
| *Crepidostomum isostomum* | Trout perch | E & W |
| *Crepidostomum hiodontos* | Moon-eye | W |
| *Crepidostomum lintoni* | Lake sturgeon | W |
| *Diplostomum scheuringi* | Yellow perch | E |
| *Macroderoides spiniferus* | Long-nosed gar | W |
| *Macroderoides typicum* | Bowfin | W |
| *Microcotyle eriensis* | Sheepshead | W |
| *Microcotyle spinicirrus* | Sheepshead | W |
| *Neascus bulboglossa* | Horned dace | E |
| *Neascus wardi* | Blue gill | E |
| *Neochasmus umbellus* | Small-mouth black bass | W |
| *Phyllodistomum superbum* | Common bullhead | W |
| *Tetracotlye communis* | Fan-tailed darter | E |
| *Tetracotyle diminuta* | Trout perch | W |
| **Cestodes** | | |
| *Corallobothrium giganteum* | Channel catfish | W |
| *Cyathocephalus americanus* | Whitefish | W |
| *Haplobothrium globuliforme* | Bowfin | W |
| *Proteocephalus singularis* | Long-nosed gar | W |
| *Proteocephalus wickliffi* | Lake herring | E & W |
| **Nematodes** | | |
| *Contracaecum brachyurum* | Small-mouthed black bass | W |
| *Contracaecum* sp. | Rock bass | W |
| *Cucullanus clitellarius* | Lake sturgeon | W |
| *Cystidicola lepisostei* | Long-nosed gar | W |
| *Cystidicoloides harwoodi* | Brook trout | E |
| *Dicotophyme* sp. | Small-mouthed black bass | W |
| *Haplonema hamulatum* | Burbot | W |
| *Haplonema immutatum* | Bowfin | W |
| *Spiroxys* sp. | Mud minnow | W |
| **Acanthocephala** | | |
| *Echinorhynchus coregoni* | Whitefish | W |
| *Neoechinorhynchus crassus* | Common sucker | W |
| *Neoechinorhynchus tenellus* | Northern pike | E |
| *Octospinifer macilentus* | Common sucker | E & W |
| *Pomphorhynchus bulbocolli* | Common sucker | W |
| **Cestodaria** | | |
| *Glaridacris catostomi* | Common sucker | E |
| *Hypocaryophyllarus paratarius* | American carp | E |
| **Protozoa** | | |
| *Cyclochaeta domerguei* | Small-mouthed black bass | W |
| *Vorticellidae* | Small-mouthed black bass | W |
| **Copepods** | | |
| *Achtheres ambloplitis* | Rock bass | W |
| *Argulus catostomi* | Black bullhead | W |
| **Leech** | | |
| *Placobdella montifera* | Large-mouthed black bass | W |

## Bibliography.

Adams, C. C., & Hankinson, T. L.

1928. The ecology and economics of Oneida Lake fish. *Roosevelt Wild Life Annals.* 1:241-548.

Agersborg, H. P. K.

1926. Studies on the effect of parasitism upon the tissue. II. With special reference to a new diplostomous trematode found in the minnow, *Notropis anogenus* Forbes. *Archiv. f. Schiffs-und Tropenhyg.,* 30:18-30.

Awerinzew, S.

1907. *Lymphocystis johnstonii.* Archiv. fur protisten kunde XIV:335.

1911. Die Entwicklungs geschichte von *Lymphocystis johnstonii Ibid.,* XXII:179.

Bangham, R. V.

1925. A study of the cestode parasites of the black bass in Ohio, with special reference to their life history and distribution. *Ohio Jour. Sci.,* 25:255-270.

1926. Parasites other than cestodes in black bass of Ohio. *Ibid.,* 26:117-127.

1927. Parasites as a limiting factor in Ohio fish hatcheries. *Jour. Parasitol.,* 13:214.

1927a. A new intermediate host of *Proteocephalus pearsei* LaRue. *Ibid.,* 13:223.

1928. Life history of bass cestode *Proteocephalus ambloplitis. Trans. Amer. Fish. Soc.,* 57:206-208.

1928a. Parasites of black bass. *Sci. Mo.,* 27:267-270.

1930. Parasites of bait minnows. *Trans. Amer. Fish. Soc.,* 59:198-201.

1934. Parasites of the spotted bass, *Micropterus pseudaplites* Hubbs, and summary of parasites of small-mouthed and large-mouthed black bass from Ohio streams. *Ibid.,* 63:220-227.

Bangham, R. V., & Hunter, G. W., III.

1936. Studies on fish parasites of Lake Erie III. *Microcotyle spinicirrus* Mac Callum (1918) Char. emend. and M. *eriensis* sp. nov. *Trans. Amer. Micros. Soc.,* 55:334-339.

Bloch, M. E.

1779. Beitrag zur Naturgeschichte der Würmer, welche in anderen Thieren leben. *Beschft. Berl. Gesellsch. natur f. Er.,* 4:534-561.

Cahn, A. R.

1927. An ecological study of southern Wisconsin fishes. The brook silversides (*Labidesthes sicculus*) and the cisco (*Leucichthys artedi*) and their relations to the region. *Ill. Biol. Monogr.,* 11:1-151.

Chandler, A. C.

1931. New genera and species of nematode worms. *Proc. U. S. Nat. Mus.,* 78; Art. 23; 11 pp.

Coker, R. E.

1917. The Bowfin: an old-fashioned fish with a new found use. *U. S. Bur. Fish. Econ.,* Cir. 26:1-7.

Cooper, A. R.

1914. On the systematic position of *Haplobothrium globuliforme* Cooper. *Trans. Royal Soc. Canad.,* 8 Sec. 4:1-5.

1914a. A new cestode from *Amia calva* L. *Trans. Roy. Canad. Inst.,* 10:81-119.

1915. Contributions to the life history of *Proteocephalus ambloplitis* Leidy. *Contrib. Canada Biol. Fac.,* II:177-194.

1915b. Trematodes from marine and fresh water fishes including one species of ectoparasitic turbellarian. *Trans. Royal Soc. Canada,* (Ser. 3) 9:181-205.

1917. A morphological study of Bothriocephalid cestodes from fishes. *Jour. Parasitol.*, 4:33-39.

1919. North American Pseudophyllidian cestodes from fishes. *Ill. Biol. Monogr.*, 4:288-541.

1920. *Glaridacus catostomi* gen. nov., sp. nov.: A cestodian parasite. *Trans. Amer. Micros. Soc.*, 39:5-24.

Cort, W. W.

1913. Notes on the trematode genus Clinostomum. *Trans. Amer. Micros. Soc.*, 32:169-182.

Cross, S. X.

1933. Some host parasite relationships of fish parasites of the Trout Lake region of northern Wisconsin. *Jour. Parasitol.*, 20:132.

1934. A probable case of non-specific immunity between two parasites of ciscoes of the Trout Lake region of northern Wisconsin. *Ibid.*, 20: 244-245.

1935. The effect of parasitism on growth of perch in the Trout Lake region. *Ibid.*, 21:267-273.

Dolley, John S.

1933. Preliminary notes on the biology of the St. Joseph River. *Amer. Midland Natural.*, 14:193-227.

Essex, H. E.

1928. The structure and development of Corallobothrium, with descriptions of two new fish tapeworms. *Ill. Biol. Monogr.*, 11:253-328.

1928a. On the life history of *Bothriocephalus cuspidatus* Cooper, 1917, a tapeworm of the wall-eyed pike. *Trans. Amer. Micros. Soc.*, 47:348-355.

1928b. *Crepidobothrium fragile*, a new species of tapeworm of the channel cat (*Ictalurus punctatus*). *Jour. Parasitol.*, 15:137.

1929. The life cycle of *Haplopothrium globuliforme* Cooper, 1914. *Sci.*, 69:677-678.

1929a. *Crepidobothrium fragile* n. sp., a tapeworm of the channel catfish. *Parasitol.*, 21:164-167.

Essex, H. E., & Hunter, G. W., III.

1926. A biological study of fish parasites from the Central States. *Trans. Ill. Acad. Sci.*, 19:151-181.

Faust, E. C.

1918. Studies on American Stephanophialinae. *Trans. Amer. Micros. Soc.*, 37:183-198.

1918a. The anatomy of *Tetracotyle iturbei* Faust, with synopsis of described Tetracotyliform larvae. *Jour. Parasitol.*, 5:69-79.

1919. Two new Proteocephalidae. *Ibid.*, 6:79-83.

Forbes, S. A.

1888. Studies of the food of fresh water fishes. *Bull. Ill. St. Lab. Nat. Hist.*, 2:433-473.

Forbes, S. A., & Richardson, R. E.

1920. The fishes of Illinois. 2nd ed. *Nat. Hist. Surv. Ill.*, 3:1-357.

Greeley, J. R. & Bishop, S. C.

1932. Fishes of the area with annotated list. *Suppl. 21st Ann. Rept. N. Y. State Cons. Dept. 1931*:54-92.

Guberlet, J. E.

1922. Three new species of Holostomidae. *Jour. Parasitol.*, 9:6-14.

1927. Studies on the control of Gyrodactylus. *Publs. in Fisheries*, Univ. Wash. Coll. of Fisheries, 2:17-29.

1929. Notes on parasitic life history studies. *Jour. Parasitol.*, 16:98-99.

HOLL, F. J.

1928. A linguatulid parasite from North American fishes. *Jour. Parasitol.*, 15:63-66.

1929. The Phyllodistomes of North America. *Trans. Amer. Micros. Soc.*, 48:48-53.

1929a. A Paramphistome from fishes. *Jour. Parasitol.*, 16:35-37.

1932. The ecology of certain fishes and amphibians with special reference to their helminth and linguatulid parasites. *Eccol. Monogr.*, 2:83-107.

HOPKINS, S. H.

1931. Studies on Crepidostomum I. *Crepidostomum isostomum* n. sp. *Jour. Parasitol.*, 17:145-150.

1931a. Studies on Crepidostomum II. The *Crepidostomum laureatum* of A. R. Cooper. *Jour. Parasitol.*, 18:79-91.

1934. The papillose Allocreadiidae. A study of their morphology, life histories, and relationships. *Ill. Monogr.*, 13:44-124.

HUBBS, C. L.

1921. An ecological study of the life history of the fresh-water atherine fish *Labidesthes sicculus*. *Eccol.*, 2:262-276.

HUGHES, R. C.

1927. Studies on the trematode family Strigeidae (Holostomidae) VI. A new metacercaria *Neascus ambloplitis*, sp. nov., representing a new larval group. *Trans. Amer. Micros. Soc.*, 46:248-267.

1928. Studies on the trematode family Strigeidae (Holostomidae) VII. *Tetracotyle pipientis* Faust. *Ibid.*, 47:42-53.

1928a. Studies on the trematode family Strigeidae (Holostomidae) IX. *Neascus van-cleavei* (Agersborg). *Ibid.*, 47:320-341.

1928b. Studies on the trematode family Strigeidae (Holostomidae) X. *Neascus bulboglossa* (Van Haitsma). *Jour. Parasitol.*, 15:52-57.

1928c. Studies on the trematode family Strigeidae (Holostomidae) XIII. Three species of Tetracotyle. *Trans. Amer. Micros. Soc.*, 47:414-433.

1928d. Studies on the trematode family Strigeidae (Holostomidae) XII. *Agamodistomum laruei* sp. nov. *Parasitol.*, 20:413-420.

1929. Studies on the trematode family Strigeidae (Holostomidae) XIV. Two new species of Diplostomula. *Occas. Papers Mus. Zool.*, Univ. Mich. No. 202, 1-29.

1929a. Studies on the trematode family Strigeidae (Holostomidae) XVII. *Tetracotyle flabelliformes*. *Papers Mich. Acad. Sci., Arts and Lett.*, 10:495-508.

1929b. Studies on the trematode family Strigeidae (Holostomidae) XIX. *Diplostomulum scheuringi* sp. nov. and *D. vergrandis* (LaRue). *Jour. Parasitol.*, 15:267-271.

HUGHES, R C., & BERKHOUT, P. G.

1929. Studies on the trematode family Strigeidae (Holostomidae) XV. *Diplostomulum gigas* sp. nov. *Papers Mich. Acad. Sci., Arts and Lett.*, 10:483-487.

HUGHES, R. C., & HALL, L. J.

1929. Studies on the trematode family Strigeidae (Holostomidae) XVI. *Diplostomulum huronense* (LaRue) *Ibid.*, 10:489-494.

HUGHES, R. C., & PISZCYEK, F. R.

1928. Studies on the trematode Strigeidae (Holostomidae) XI. *Neascus ptychocheilus* (Faust). *Jour. Parasitol.*, 15:58-62.

HUNNINEN, A. V., & HUNTER, G. W., III.

1933. On the species of Crepidostomum in trout. *Trans. Amer. Micros. Soc.*, 52:150-157.

HUNTER, G. W., III.

1927. Notes on the Caryophyllaeidae of North America. *Jour. Parasitol.*, 14:16-26.

1928. Contributions to the life history of *Proteocephalus ambloplitis* (Leidy). *Ibid.*, 14:229-242.

1929. New Caryophyllaeidae from North America. *Jour. Parasitol.*, 15:185-192.

1929a. Life history studies on *Proteocephalus pinguis* LaRue. *Parasitol.*, 21:487-496.

1930. Contributions to the life cycle of *Centrovarium lobotes* (MacCallum 1895). *Jour. Parasitol.*, 17:108.

1930a. Studies on the Caryophyllaeidae of North America. *Ill. Biol. Monogr.*, 11:370-556.

1932. A new trematode (*Plesiocreadium parvum* n. sp.) from fresh-water fish. *Trans. Amer. Micros. Soc.*, 51:16-21.

1932a. An artificial lake with a low percentage of infected fish. *Ibid.*, 51:22-27.

1933. The Strigeid trematode *Crassiphiala ambloplitis* (Hughes 1927). *Parasitol.*, 25:510-517.

HUNTER, G. W., III, & BANGHAM, R. V.

1932. Studies on fish parasites of Lake Erie. I. New trematodes (Allocreadiidae). *Trans. Amer. Micros. Soc.*, 51:137-152.

1933. Studies on fish parasites of Lake Erie. II. New Cestodes and Nematodes. *Jour. Parasitol.*, 29:304-311.

HUNTER G. W., III, & HUNNINEN, A. V.

1934. Studies on the plerocercoid larva of the bass tapeworm *Proteocephalus ambloplitis* (Leidy) in the small-mouthed bass, *Suppl. 23rd Ann. Rept. N. Y. State Cons. Dept., 1933*:255-261.

HUNTER, G. W., III, & HUNTER, W. S.

1929. Further experimental studies on the bass tapeworm *Proteocephalus ambloplitis* (Leidy). *Suppl. 18th Ann. Rept. N. Y. State Cons. Dept., 1928*:198-207.

1930. Studies on the parasites of fishes of the Lake Champlain watershed. *Suppl. 19th Ann. Rept. N. Y. State Cons. Dept., 1929*:241-260.

1930a. Contributions to the life history of *Neascus ambloplitis* Hughes 1927. *Jour. Parasitol.*, 17:108.

1931. Studies on fish parasites in the St. Lawrence watershed. *Suppl. 20th Ann. Rept. N. Y. State Cons. Dept., 1930*:197-216.

1932. Studies on parasites of fish and of fish-eating birds. *Suppl. 21st Ann. Rept. N. Y. State Cons. Dept., 1931*:252-271.

1934. Studies on fish and bird parasites. *Suppl. 23rd Ann. Rept. N. Y. State Cons. Dept., 1933*:245-254.

HUNTER, W. S.

1928. A new strigeid larva *Neascus wardi*. *Jour. Parasitol.*, 15:104-114.

1933. A new strigeid metacercaria *Neascus rhinichthysi*, n. sp. *Trans. Amer. Micros. Soc.*, 52:255-258.

KANOUSE, BESSIE A.

1932. A physiological and morphological study of *Saprolegnia parasitica*. *Mycologia*, 24:431-452.

KUDO, R. R.

1931. Handbook of Protozoology. C. C. Thomas, Springfield. 451 pp.

LAMONT, M. E.

1921. Two new parasitic flatworms. *Occas. Papers Mus. Zool. Univ. Mich.*, No. 93; 4 pp.

LaRue, G. R.

1909. On the morphology and development of a new cestode of the genus Proteocephalus Weinland. *Trans. Amer. Micros. Soc.* 28:17-49.

1911. A revision of the cestode family Proteocephalidae. *Zool. Anz.*, 38:473-482.

1914. A revision of the cestode family Proteocephalidae. *Ill. Biol. Bonogr.*, 1:1-350.

1919. A new species of tapeworm of the genus Proteocephalus from the perch and the rock bass. *Occas. Papers Mus. Zool.*, Univ. Mich., No. 67; 10 pp.

1926. Studies on the trematode family Strigeidae (Holostomidae) I. *Pharyngostomum cordatum* (Diesing) Ciurea. *Trans. Amer. Micros. Soc.*, 45:1-10.

1926a. Studies on the trematode family Strideidae (Holostomidae) II. Taxonomy. *Ibid.*, 45:11-19.

1926b. Studies on the trematode family Strigeidae (Holostomidae) III. Relationships. *Ibid.*, 45:265-281.

1927. Studies on the trematode family Strigeidae (Holostomidae) V. *Proalaria huronensis* sp. nov. *Ibid.*, 46:26-35.

1932. Morphology of *Cotylurus communis* Hughes (Trematoda: Strigeidae). *Ibid.*, 51:28-47.

LaRue, G. R., Butler, E. R., & Berkhout, R. G.

1926. Studies on the trematodes family Strigeidae (Holostomidae) IV. The eyes of fishes, an important habitat for larval Strigeidae. *Ibid.*, 45:282-288.

Leidy, J.

1851. Contributions to helminthology. *Proc. Acad. Nat. Sci. Phila.*, 5:205-209.

1853. On nodular bodies embedded in the tail and fins of fishes, a parasitic worm of the genus Distoma. *Ibid.*, 6:433.

1855. Notices on some tapeworms. *Ibid.*, 7:43.

1882. Filaria in the black bass. *Ibid.*, 34:69.

1885. Bothriocephalus in trout. *Ibid.*, 37:122-123.

1886. On Amia and its probable Taenia. *Ibid.*, 38:62.

1888. Parasites of the pickerel. *Ibid.*, 40:169.

1888a. Parasites of the striped bass. *Ibid.*, 40:124-125.

Linton, E.

1891. A contribution to the life history of *Dibothrium cordiceps*, a parasite infesting the trout of Yellowstone Lake. *Bull. U. S. Fish. Comm.*, 9:337-358.

1891a. On two species of larval Dibothria from Yellowstone National Park. *Ibid.*, 9:65-78.

1893. On fish entozoa from Yellowstone National Park. *Rept. U. S. Comm. Fish and Fisheries* (1889-1891) :545-564.

1894. Some observations concerning fish parasites. *Ibid.*, 13:101-112.

1897. Notes on the cestode parasite of fishes. *Proc. U. S. Natl. Mus.*, 20:423-456.

1898. Notes on the trematode parasites of fishes. *Ibid.*, 20:507-548.

1898a. An economical consideration of fish parasites. *Bull. U. S. Fish. Comm.*, 17:194-199.

1900. Fish parasites collected at Woods Hole in 1898. *Ibid.*, 18:267-304.

1901. Parasites of fishes of the Woods Hole region. *Ibid.*, 19:405-492.

1907. Preliminary report on parasites collected at Tortugas, Fla., June 30 to July 18, 1906. *Yearbook Carnegie Inst. of Wash.*, 5:112-117.

1910. Helminth fauna of Dry Tortugas II. Trematodes. *Pub. Carnegie Inst. of Wash.*, No. 133:11-98.

1911. Trematode parasites in the skin and flesh and the agency of birds in their occurrence. *Trans. Amer. Fish. Soc.*, 41:245-259.

1914. On the seasonal distribution of fish parasites. *Ibid.*, 44:48-56.

1925. Notes on the Bothriocephalus sp. from *Coregonus quadrilateralis*. *Ann. Rept. New York State Cons. Comm.*, 1925:96.

MacCallum, W. G.

1895. On the anatomy of two distome parasites of fresh-water fish. *Veterin. Mag.*, 2:1-12.

Manter, H. W.

1926. Some North American fish trematodes. *Ill. Biol. Mongr.*, 10:127-264.

Marshall, W. S., & Gilbert, N. C.

1905. Three new trematodes found principally in black bass. *Zool. Jahrb.*, Bd. 22:477-488.

Miller, M. J.

1936. *Bunoderina eucaliae* gen. et sp. nov., A new papilose Allocreadiidae from the Stickleback. *Canad. Jour. Res.*, 14:11-14.

Moore, E.

1925. Diseases of fish in state waters. *14th Ann. Rept. N. Y. State Cons. Dept., 1924*:83-97.

1926. Problems in fresh-water fisheries. *15th Ann. Rept. N. Y. State Cons. Dept., 1925*;22 pp.

Moore, J. P.

1912. Classification of the leeches of Minnesota. Geol. and Nat. Hist. Surv. Minn., Zool. Series, No. V, Pt. III, p. 105.

Moulton, J. M.

1931. A new species of Haplonema Ward and Magath 1916 from the stomach of *Lota maculosa*. *Jour. Parasitol.*, 18:105-107.

Mueller, J. F.

1930. The trematode genus Plagiorchis in fishes. *Trans. Amer. Micros. Soc.*, 49:174-177.

1932. *Trichodina renicola* (Mueller 1931), a ciliate parasite of the urinary tract of *Esox niger*. *Roosevelt Wild Life Annals*, 3:139-154.

1933. On the status of the genus Dachnitoides. *Jour. Parasitol.*, 20:76.

1934. Notes on *Microphallus obstipus* and *M. medius* Van Cleave and Mueller. *Proc. Helminth. Soc. Wash.*, 1:5.

Mueller, Justus F., & Van Cleave, Harley J.

1932. Parasites of Oneida Lake fishes. Part 2. Descriptions of new species and some general taxonomic considerations, especially concerning the trematode family Heterophyidae. *Roosevelt Wild Life Annals*, 3:77-137.

Osborn, H. L.

1902. Notes on the trematodes of Lake Chautauqua, N. Y., *Sci.* (n. s.), 15:573-574.

1903. On the structure of *Cryptogonimus chyli* n. sp., a trematode from Lake Chautauqua, N. Y., with novel type of ventral sucker. *Ibid.*, 17:533-534.

1903a. *Bunodera cornuta* sp. nov., a new parasite from the crayfish and certain fishes of Lake Chautauqua, New York. *Bio. Bull.*, 5:63-73.

1903b. On Cryptogonimus (n. g.) chyli (n. sp.), a fluke with two ventral suckers. *Zool. Anz.*, Bd. 26:315-318.

1910. On the structure of *Cryptogonimus chyli*, an aberrant distome from fishes of Michigan and New York. *Jour. Exp. Zool.*, 9:517-536.

1911. On the distribution and mode of occurrence in the United States and Canada of *Clinostomum marginatum*, a trematode parasitic in fish, frogs, and birds. *Biol. Bull.*, 20:350-366.

1912. On the structure of *Clinostomum marginatum*, a trematode parasite of the frog, bass and heron. *Jour. Morphol.*, 23:189-223.

1919. Observation on *Microphallus ovatus* sp. nov. from the crayfish and black bass of Lake Chautauqua, New York. *Jour. Parasitol.*, 5:123-127.

PEARSE, A. S.

1924. Observations on parasitic worms from Wisconsin fishes. *Trans. Wis. Acad. Sci., Arts, Letters*, 21:147-160.

1924a. The parasites of lake fishes. *Ibid.*, 21:161-194.

PRATT, H. S.

1900. Synopses of North American invertebrates. XII. The trematodes. Part I. The Heterocotylea or monogenetic forms. *Amer. Nat.*, 34:645-662.

1902. Synopses of North American invertebrates XII. The trematodes. Part II. The Aspidocotylea and the Malacocotylea, or digenetic forms. *Ibid.*, 36:887-910, 953-979.

RICH, W. H.

1923. Progress in biological inquiries. *Rept. Div. Sci. Inq. Fiscl. Yr. 1923 Bur. Fish. Doc. 956.*

RILEY, I.

1918. Preliminary report of "wormy" fish in Bass Lake, Mahnomem County, Minnesota. *Fins, Feathers, and Fur*, Sept., 1918:2-3.

RIMSKY-KORSAKOFF, V. N.

1930. The food of certain fishes of the Lake Champlain watershed. *Suppl. 19th Ann. Rept. N. Y. State Cons. Dept., 1929*:88-104.

SIBLEY, C. K.

1929. The food of certain fishes of the Lake Erie drainage basin. *Suppl. 18th Ann. Rept. N. Y. State Cons. Dept., 1928*:180-188.

SIBLEY, C. K. & RIMSKY-KORSAKOFF, V. N.

1931. Food of certain fishes in the St. Lawrence Watershed. *Suppl. 20th Ann. Rept. N. Y. State Cons. Dept., 1930*:109-120.

SIMER, P. H.

1929. Fish trematodes from the lower Tallahatchie River. *Amer. Midland Nat.*, 2:563-588.

1930. A preliminary study of the cestodes of the spoonbill *Polyodon spathula* (Wal.) *Trans. Ill. State Acad. Sci.*, 22:139-145.

STAFFORD, J.

1900. Some undescribed trematodes. *Zool. Jahrb.*, Bd. 13:399-414.

1904. Trematodes from Canadian fishes. *Zool. Anz.*, Bd. 27:481-495.

SURBER, E. W.

1928. *Megalogonia ictaluri*, a new species of trematode from the channel catfish. *Jour. Parasitol.*, 14:269-271.

THOMAS, L. J.

1929. *Philometra nodulosa* nov. sp. *Jour. Parasitol.*, 15:193-198.

1930. Notes on the life history of *Haplobothrium globuliforme* Cooper, a tapeworm of *Amia calva*, L. *Ibid.*, 16:140-145.

TIFFANY, L. H.

1921. Algal food of the young gizzard shad. *Ohio Jour. Sci.*, 21:113-122.

Van Cleave, H. J.

1913. The genus Neorhynchus in North America. *Zool. Anz.*, 43:177-190.

1916. Seasonal distribution of some acanthocephala from fresh-water hosts. *Jour. Parasitol.*, 2:106-110.

1919. Acanthocephala from the Illinois River, with descriptions of species and a synopsis of the family Neoechinorhynchidae. *Bull. Ill. Nat. Hist. Surv.*, 13:222-257.

1919a. Acanthocephala from fishes of Douglass Lake, Michigan. *Occas. Papers Mus. Zool. Univ. Mich.*, No. 72:1-12.

1920. Notes on the life cycle of two species of Acanthocephala from fresh-water fishes. *Jour. Parasitol.*, 6:167-172.

1921. Notes on two genera of ectoparasitic trematodes from fresh-water fishes. *Jour. Parasitol.*, 8:33-39.

1922. A new genus of trematodes from the white bass. *Proc. U. S. Natl. Museum*, 61:art. 9, 1-8.

1923. Acanthocephala from the fishes of Oneida Lake, New York. *Roosevelt Wild Life Bull.*, 2:73-84.

1931. New acanthocephala from fishes of Mississippi and a taxonomic reconsideration of forms with unusual numbers of cement glands. *Trans. Amer. Micros. Soc.*, 50:348-363.

Van Cleave, Harley J., & Mueller, Justus F.

1932. Parasites of Oneida Lake fishes. Part I. Descriptions of new genera and new species. *Roosevelt Wild Life Annals*, 3:1-72.

1934. Parasites of Oneida Lake fishes. Part III. A biological survey of the worm parasites. *Roosevelt Wild Life Annals*, 7:159-334.

Van Haitsma, J. P.

1925. *Crassiphiala bulboglossa* nov. gen., nov. spec., a holostomatid trematode from the belted kingfisher, *Ceryle alcyon* Linn. *Trans. Amer. Mic. Soc.*, 44:121-131.

Ward, H. B.

1894. Some notes on the biological relations of the fish parasites of the great lakes. *Proc. Nebr. Acad. Sci.*, 4:8-11.

1894a. On the parasites of lake fish. I. Notes on the structure and life history of *Distoma opacum*, n. sp. *Proc. Amer. Micros. Soc.*, 15:173-182.

1894b. A preliminary report on the worms (mostly parasitic) collected in Lake St. Clair in the summer of 1893. *Bull. Mich. Fish. Comm.*, 4:1-49.

1901. Notes on the parasites of lake fish. III. On the structure of the copulatory organs in Microphallus nov. gen. *Trans. Amer. Mic. Soc.*, 22:175-187.

1910. Internal parasites of the Sebago salmon. *Bull. U. S. Bur. Fish.*, 28:1153-1194.

1912. The distribution and frequency of animal parasites and parasitic diseases in North American fresh-water fish. *Trans. Amer. Micros. Soc.*, 41:207-241.

Ward, H. B. & Magath T. B.

1917. Notes on some nematodes from fresh-water fishes. *Jour. Parasitol.*, 3:57-64.

Ward, H. B. & Whipple, G. C.

1918. Fresh water biology. N. Y., John Wiley and Sons. 1111 pp.

Wigdor, M.

1918. Two new nematodes common in some fishes of Cayuga Lake. *Jour. Parasitol.*, 5:29-34.

Winfield, G. F.

1929. *Plesiocreadium typicum*, a new trematode from *Amia calva*. *Jour. Parasitol.*, 16:81-87.

Woodcock, H. M.
1904. *Lymphocystis johnstonii. Trans. Biol. Soc. Liverpool,* XVIII:143.

Woodhead, A. E.
1926. Concerning the encystment of Bucephalus cercariae. *Sci.,* 65:232.
1929. Life history studies on the trematode family Bucephalidae. *Trans. Amer. Micros. Soc.,* 48:256-275.
1930. Life history studies on the trematode family Bucephalidae. No. II. *Ibid.,* 49:1-17.
1932. The germ cell cycle in trematodes. *Jour. Parasitol.,* 19:164.

Yorke, W. & Maplestone, P. A.
1926. The Nematode Parasites of Vertebrates. P. Blakiston's Son & Co., Philadelphia, 536 pp.

## APPENDIX. SUMMARY OF PARASITISM BY SPECIES OF FISH.

This appendix contains the detailed host records on all fish examined by families and species of fish. The total number of each species of fish examined is indicated before the name of the host. This figure is then subdivided into data for the eastern and western ends of the lake, under "E" and "W." The number examined from each end is indicated, while the number of infected fish occurs in parentheses. The species of parasites is then listed together with data on the number and degree of infection as well as the location in the host. See also footnote 1, page 385.

Abbreviations in Tables.

E—East
W—West
*—1-9 parasites
**—10-49 parasites
***—50 parasites and over
†—larval or immature form
A—air bladder
C—coelom
D—digestive tract
E—external
F—flesh
G—gills
I—intestine
K—kidneys
L—liver
M—mesenteries
P—pericardial cavity
R—reproductive organs
S—spleen
U—urinary bladder

Table 1.
Summary of Parasitism in the Acipenseridae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 2 *Acipenser fulvescens* Raf. | Trematodes | | |
| Lake sturgeon | *Crepidostomum lintoni* | W 2 * | D |
| 2 (2) W. | *Allocreadium* sp. | W 1 * | D |
| | Nematodes | | |
| | *Cucullanus clitellarius* | W 2 * | D |

TABLE 2.

Summary of Parasitism in the Lepisosteidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 9 *Lepisosteus osseus* (Linn.) Long-nosed gar 1 (0) E; 8 (8) W. | TREMATODES | | |
| | *Macroderoides spiniferus* | W 4 * | D |
| | | 1 ** | D |
| | CESTODES | | |
| | *Proteocephalus singularis* | W 6 * | D |
| | †*Proteocephalus ambloplitis* | W 2 * | M & L |
| | | 1 ** | M & L |
| | | 3 * | L |
| | | 1 ** | L |
| | †*Bothriocephalus* sp. | W 1 * | D |
| | NEMATODES | | |
| | *Cystidicola lepisostei* | W 2 * | I |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 1 * | D |

TABLE 3.

Summary of Parasitism in the Amiidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 3 *Amia calva* Linn. Bowfin 3 (3) W. | TREMATODES | | |
| | *Crepidostomum cornutum* | W 1 * | D |
| | *Microphallus opacus* | W 1 ** | D |
| | *Leuceruthrus micropteri* | W 1 * | D |
| | CESTODES | | |
| | *Proteocephalus ambloplitis* | W 2 ** | D |
| | *Haplobothrium globuliforme* | W 1 * | D |
| | NEMATODES | | |
| | *Haplonema immutatum* | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 1 * | D |
| 1 young *Amia calva* | TREMATODES | | |
| | *Macrodcroides typicum* | W 1 ** | D |

TABLE 4.

Summary of Parasitism in the Hiodontidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 28 *Hiodon tergisus* Le Sueur Moon-eye 16 (6) E; 12 (9) W. | TREMATODES | | |
| | *Crepidostomum illinoiense* | W 5 * | D |
| | | 2 ** | D |
| | *Leuceruthrus* sp. | W 1 * | D |
| | *Tetracotyle* sp. | W 1 * | M |
| | CESTODES | | |
| | *Bothriocephalus cuspidatus* | W 1 * | D |
| | †*Proteocephalus* sp. | W 1 * | D |
| | NEMATODES | | |
| | *Rhabdochona cascadilla* | E 4 * | D |
| | | W 6 * | D |
| | *Camallanus oxycephalus* | E 5 * | D |
| | | 1 ** | D |

TABLE 5.
Summary of Parasitism in the Clupeidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 1 young *Dorosoma cepedianum* (Le Sueur) | NEMATODES | | |
| Gizzard shad | *Agamonema* sp. | W 1 * | D |
| 1 (1) W. | | | |

4 adults of this species examined from the western end were negative.

TABLE 6.
Summary of Parasitism in the Coregonidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 78 *Leucichthys artedi* (Le Sueur) | CESTODES | | |
| Lake herring | *Proteocephalus exiguus* | E 9 * | D |
| 63 (16) E; 15 (14) W. | | 6 ** | D |
| | | 1 *** | D |
| | | W 7 * | D |
| | | 3 ** | D |
| | †*Abothrium crassum* | W 4 * | 3 M |
| | | | 1 I |
| | *Proteocephalus wickliffi* | E 3 * | D |
| | | W 6 * | D |
| | NEMATODES | | |
| | *Cystidicola stigmatura* | W 1 * | A |
| 24 *Coregonus clupeaformis* (Mitchill) | TREMATODES | | |
| Whitefish | Unidentified | W 1 * | D |
| 9 (6) E; 15 (15) W. | CESTODES | | |
| | *Abothrium crassum* | E 1 * | D |
| | | W 2 * | D |
| | †*Schistocephalus* sp. | W 1 * | P |
| | *Proteocephalus exiguus* | E 2 * | D |
| | | 3 ** | D |
| | | 1 *** | D |
| | | W 1 * | D |
| | | 2 *** | D |
| | NEMATODES | | |
| | *Cystidicola stigmatura* | W 3 * | A |
| | ACANTHOCEPHALA | | |
| | *Echinorhynchus coregoni* | E 1 * | D |
| | | 4 ** | D |
| | | W 10 * | D |
| | | 4 ** | D |
| | †*Echinorhynchus* sp. | W 1 * | C |
| 6 young *C. clupeaformis* | CESTODES | | |
| | †*Proteocephalus exiguus* | W 4 # * | D |
| 6 (6) W. | | 2 ** | D |

# One carried 8 larval and a single adult form of this cestode.

TABLE 7.
Summary of Parasitism in the Salmonidae.

| Hosts | Parasites | Number infected & degree | Location in host |
|---|---|---|---|
| 63 *Salvelinus fontinalis* (Mitchill) | NEMATODES | | |
| Brook trout | *Cystidicoloides harwoodi* | E 40 * | D |
| 63 (40) E. | | | |

TABLE 8.
Summary of Parasitism in the Catostomidae.

| Hosts | Parasites | Number infected & degree | Location in host |
|---|---|---|---|
| 16 *Carpiodes cyprinus* (Le Sueur) | CESTODARIA | | |
| | *Hypocaryophyllaeus paratarius* | E 1 * | D |
| White carp | NEMATODES | | |
| 13 (5) E; 3 (0) W. | *Rhabdochona cascadilla* | E 5 * | D |
| 21 *Catostomus commersonnii* (Lacépède) | CESTODARIA | | |
| | *Glaridacris catostomi* | E 4 * | D |
| Common sucker | CESTODES | | |
| 13 (8) E; 8 (8) W. | †*Ligula intestinalis* | E 2 * | C |
| | | W 1 * | C |
| | †*Triaenophorus nodulosus* | E 1 * | L |
| | | W 1 * | L |
| | NEMATODES | | |
| | *Agamonema* sp. | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | *Octospinifer macilentus* | E 3 * | D |
| | | W 1 * | D |
| | *Neoechinorhynchus crassus* | W 3 * | D |
| | | 1 ** | D |
| | *Pomphorhynchus bulbocolli* | W 2 * | D |
| 21 *Hypentylium nigricans* (Le Sueur) | PROTOZOA | | |
| | Myxosporidia | W 1 * | F |
| Hog sucker | | | |
| 20 (0) E; 1 (1) W. | | | |
| 3 *Moxostoma aureolum* (Le Sueur) | TREMATODES | | |
| | *Neascus* sp. | W 1 * | L |
| Common red horse or Red-fin mullet | NEMATODES | | |
| 2 (1) E; 1 (1) W. | Unidentified | E 1 * | D |
| 8 *Moxostoma lesueurii* (Richardson) | NEMATODES | | |
| | *Rhabdochona cascadilla* | W 1 * | D |
| Short-headed red-fin mullet or Red horse | PROTOZOA | | |
| 6 (0) E; 2 (2) W. | Myxosporidia | W 1 ** | G |

14 *Moxostoma duquesnii* (Le Sueur), fine-scaled red-fin mullet, and 9 *M. anisurum* Raf., white-nosed red-fin mullet, were examined from the eastern end of the lake and found to be negative.

TABLE 9.
Summary of Parasitism in the Cyprinidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 13 *Cyprinus carpio* Linn. | TREMATODES | | |
| German carp | *Neascus vancleavei* | W 1 * | M |
| 7 (1) E; 6 (2) W. | CESTODES | | |
| | In those from eastern end, outer wall of digestive tract riddled with degenerated cysts. | | |
| | NEMATODES | | |
| | *Agamonema* sp. | W 2 * | D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | E 1 * | D |
| 13 *Carassius auratus* (Linn.) | NEMATODES | | |
| | *Agamonema* sp. | W 3 * | D |
| Goldfish | ACANTHOCEPHALA | | |
| 2 (0) E; 11 (4) W. | *Pomphorhynchus* sp. | W 1† * | D |
| 18 *Nocomis micropogon* (Cope) | TREMATODES | | |
| | *Neascus vancleavei* | E 4 * | M |
| 18 (9) E. | | 3 ** | L |
| | *Neascus* sp. | E 2 * | F |
| | | 1 ** | F |
| | | 1 *** | F |
| | NEMATODES | | |
| | *Agamonema* sp. | E 1 * | D |
| 31 *Erinemus storerianus* (Kirtland) | TREMATODES | | |
| | *Neascus* sp. | W 4 * | M |
| Storer's chub | Strigeidae | W 6 * | M |
| 31 (20) W. | *Lebouria cooperi* | W 7 * | D |
| | | 3 ** | D |
| | CESTODES | | |
| | †*Ligula intestinalis* | W 2 * | C |
| | NEMATODES | | |
| | *Agamonema* sp. | W 2 * | D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 1 * | D |
| 54 *Rhinichthys atronasus* (Mitchill) | TREMATODES | | |
| | *Neascus vancleavei* | E 1 * | L |
| Black-nosed dace | *Neascus rhinichthysi* | E 13 * | F |
| 54 (27) E. | | 11 ** | F |
| | | 3 *** | F |
| 51 *Rhinichthys cataractae* (Cuvier & Valenciennes) | TREMATODES | | |
| | *Neascus rhinichthysi* | E 6 * | F |
| | | 2 ** | F |
| Long-nosed dace | *Lebouria cooperi* | W 3 * | D |
| 41 (13) E; 10 (4) W. | NEMATODES | | |
| | *Camallanus oxycephalus* | W 1† * | D |
| | | W 1 * | D |

Summary of Parasitism in the Cyprinidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 40 *Semotilus atromaculatus* (Mitchill) | TREMATODES | | |
| Horned dace | *Neascus vancleavei* | E 1 * | L |
| 40 (24) E. | | 1 ** | L |
| | *Neascus bulboglossa* | E 1 * | F |
| | | 6 ** | F |
| | | 15 *** | F |
| | CESTODES | | |
| | *Proteocephalus* sp. | E 1 * | D |
| | NEMATODES | | |
| | *Agamonema* sp. | E 1 * | D |
| 10 *Opsopoeodus emiliae* Hay | TREMATODES | | |
| | *Neascus* sp. | W 1 * | M |
| Pug-nosed minnow | *Lebouria cooperi* | W 1 * | D |
| 10 (2) W. | CESTODES | | |
| | †*Ligula intestinalis* | W 2 * | C |
| 8 *Notropis heterodon* (Cope) | TREMATODES | | |
| | *Neascus* sp. | W 1 * | M |
| Black-nosed shiner | NEMATODES | | |
| 8 (3) W. | *Agamonema* sp. | W 1 * | D |
| | *Camallanus oxycephalus* | W 1 * | D |
| 14 *Notropis volucellus* (Cope) | TREMATODES | | |
| | *Neascus* sp. | W 1 * | M |
| | *Lebouria cooperi* | W 6 * | D |
| 14 (7) W. | NEMATODES | | |
| | *Rhabdochona cascadilla* | W 1 * | D |
| 12 *Notropis deliciosus stramineus* (Cope) | TREMATODES | | |
| | *Neascus* sp. | W 1 * | M |
| Straw-colored minnow | *Lebouria cooperi* | W 4 * | D |
| 3 (1); 9 (4) W | CESTODES | | |
| | †*Ligula intestinalis* | E 1 * | C |
| | PROTOZOA | | |
| | Myxosporidia | W 1 * | G |
| 94 *Notropis hudsonius* (Clinton) | TREMATODES | | |
| | *Neascus vancleavei* | E 1 * | M |
| Spot-tailed minnow | *Neascus* sp. | W 8 * | M |
| 11 (5) E; 83 (58) W | *Tetracotyle* sp. | W 4 * | M |
| | *Lebouria cooperi* | W 15 * | D |
| | CESTODES | | |
| | †*Ligula intestinalis* | E 2 * | C |
| | | W 37 * | C |
| | †*Proteocephalus ambloplitis* | W 1 * | L |
| | *Proteocephalus* sp. ‡ | W 1 * | D |
| | NEMATODES | | |
| | *Agamonema* sp. | W 1 * | D |
| | *Camallanus oxycephalus* | W 3 * | D |
| | *Rhabdochona cascadilla* | W 2 * | D |
| | PROTOZOA | | |
| | Myxosporidia | E 2 *** | F |
| | | W 2 ** | F |
| | | 1 * | F |

‡ A single strobila representing a new undescribed species.

Summary of Parasitism in the Cyprinidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 58 *Notropis whipplii* (Girard) | TREMATODES | | |
| Steel-colored minnow | *Lebouria cooperi* | E 5 * | D |
| 9 (5); 49 (20) W | | W 6 * | D |
| | *Neascus* sp. | W 1 * | L |
| | | 2 ** | F, L |
| | CESTODES | | |
| | †*Ligula intestinalis* | W 4 * | C |
| | NEMATODES | | |
| | *Agamonema* sp. | E 1 * | D |
| | | W 1 * | D |
| | *Camallanus oxycephalus* | W 5 * | D |
| | *Rhabdochona cascadilla* | W 11 * | D |
| | LEECHES | | |
| | *Piscicola punctata* | W 1 * | E |
| 144 *Notropis atherinoides* Raf. | TREMATODES | | |
| Lake shiner | Strigeidae | W 1 * | M |
| 63 (10) E; 81 (35) W | *Leuceruthrus* sp. | W 1 * | D |
| | *Lebouria cooperi* | W 26 * | D |
| | | 1 ** | D |
| | *Neascus vancleavei* | W 3 * | L |
| | CESTODES | | |
| | †*Proteocephalus pinguis* | E 7 * | D |
| | †*Bothriocephalus cuspidatus* | E 3 * | D |
| | | W 2 * | D |
| | | 1 ** | D |
| | †*Proteocephalus ambloplitis* | W 3 * | M |
| | *Proteocephalus* sp. | W 2† * | D |
| | | 1 * | D |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 1 * | D |
| | PROTOZOA | | |
| | Myxosporidia | W 1 ** | G |
| 35 *Notropis cornutus* (Mitchill) | TREMATODES | | |
| Common shiner | *Neascus vancleavei* | E 2 * | L |
| 34 (14) E; 1 (0) W. | | 1 ** | M |
| | *Neascus* sp. | E 4 * | F |
| | | 4 ** | F |
| | | 1 *** | F |
| | CESTODES | | |
| | †*Ligula intestinalis* | E 2 * | C |
| 3 *Ericymba buccata* Cope | TREMATODES | | |
| Silvery-jawed minnow | *Neascus bulboglossa* | W 1 ** | D |
| 3 (1) W | NEMATODES | | |
| | *Camallanus oxycephalus* | W 1 * | D |
| 12 *Notemigonus crysoleucas* (Mitchill) | TREMATODES | | |
| | *Neascus* sp. | E 2 * | F |
| Golden shiner | NEMATODES | | |
| 5 (2) E; 7 (1) W. | *Agamonema* sp. | W 1 * | D |
| | PROTOZOA | | |
| | Myxosporidia | W 1 *** | G |

Summary of Parasitism in the Cyprinidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 13 *Hyborhynchus notatus* (Raf.) | TREMATODES | | |
| Blunt-nosed minnow | *Neascus* sp. | E 2 * | F |
| 3 (2) E; 10 (3) W. | *Lebouria cooperi* | W 1 * | D |
| | *Neascus vancleavei* | W 1 * | L |
| | CESTODES | | |
| | †*Ligula intestinalis* | W 1 * | C |
| | PROTOZOA | | |
| | Myxosporidia | W 1 ** | E |
| 11 *Pimephales promelas* Raf. | TREMATODES | | |
| Fat-head minnow | *Neascus* sp. | W 2 * | L |
| 9 (2); 2 (2) W | PROTOZOA | | |
| | Myxosporidia | E 2 *** | I |
| 16 *Campostoma anomalum* (Raf.) | TREMATODES | | |
| Stone roller | *Neascus vancleavei* | E 4 * | L |
| | | W 1 * | L |
| 14 (7) E; 2 (1) W. | *Neascus* sp. | E 1 * | F |
| | | 1 ** | F |
| | | 1 *** | F |

8 *Notropis heterolepis*, Eigenmann & Eigenmann, from the western end, 1 *Notropis rubrifrons* (Cope) from the western end and 13 *Notropis umbratilis* (Girard) from the eastern end were negative.

TABLE 10.

Summary of Parasitism in the Ameiuridae (Siluridae).

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 36 *Ictalurus punctatus* (Raf.) | TREMATODES | | |
| Channel catfish | Gyrodactyloidea | W 1 * | G |
| | | 2 ** | G |
| 7 (2) E; 29 (29) W. | *Megalogonia ictaluri* | W 4 * | D |
| | | 1 ** | D |
| | *Vietosoma parvum* | W 2 * | D |
| | *Acetodextra amiuri* | W 1 * | R |
| | *Macroderoides* sp. | W 1 * | D |
| | *Phyllodistomum* sp. | W 1 * | U |
| | CESTODES | | |
| | *Corallobothrium fimbriatum* | E 2 * | D |
| | | W 7 * | D |
| | | 2 ** | D |
| | | 2† * | D |
| | | 4† ** | D |
| | *Corallobothrium giganteum* | W 1 * | D |
| | NEMATODES | | |
| | *Spinitectus gracilis* | W 4 * | D |
| | *Agamonema* sp. | W 4 * | D |
| | †*Camallanus oxycephalus* | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | †*Leptorhynchoides thecatus* | W 4 * | M |
| | *Pomphorhynchus* sp. | W 1 * | D |

Summary of Parasitism in the Ameiuridae (Siluridae).—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 36 *Ictalurus punctatus* (Raf.) continued | COPEPODS | | |
| | *Ergasilus versicolor* | W 4 * | G |
| | *Achtheres pimelodi* | W 1 * | G |
| | PROTOZOA | | |
| | Myxosporidia | W 5 * | G |
| | | 3 ** | G |
| | | 1 *** | G |
| 1 *Villarius lacustris* (Walbaum) Lake catfish 1 (1) E. | PROTOZOA | | |
| | Lymphocystis | E 1 ** | L, K & M |
| 19 *Ameiurus melas* Raf. Black bullhead 19 (12) W. | TREMATODES | | |
| | *Megalogonia ictaluri* | W 1 * | D |
| | *Clinostomum marginatum* | W 1 * | F |
| | *Leuceruthrus micropteri* | W 1 * | D |
| | *Crepidostomum* sp. | W 1 * | D |
| | CESTODES | | |
| | *Corallobothrium fimbriatum* | W 3 * | D |
| | *Corallobothrium* n. sp. | W 1 * | D |
| | †*Proteocephalus ambloplitis* | W 2 * | M |
| | NEMATODES | | |
| | *Dichelyne cotylophora* | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | †*Leptorhynchoides thecatus* ♯ | W 1 * | M |
| ♯ New definitive host record. | LEECHES | | |
| | *Piscicola punctata* | W 3 * | E |
| 8 *Ameiurus nebulosus* (Le Sueur) Common bullhead 7 (0) E; 1 (1) W. | TREMATODES | | |
| | *Phyllodistomum superbum* | W 1 * | U |
| | *Clinostomum marginatum* | W 1 * | F |
| | CESTODES | | |
| | *Corallobothrium* n. sp. | W 1 * | D |
| | NEMATODES | | |
| | *Agamonema* sp. | W 1 * | D |
| 5 *Noturus flavus* Raf. Yellow stone cat. 5 (4) W. | TREMATODES | | |
| | *Megalogonia ictaluri* | W 1 * | D |
| | CESTODES | | |
| | *Corallobothrium fimbriatum* | W 2 * | D |
| | †*Proteocephalus ambloplitis* | W 1 * | L |
| | NEMATODES | | |
| | *Spinitectus gracilis* | W 1 * | D |
| | *Camallanus oxycephalus* | W 2 * | D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 2† * | M |
| | | 2 * | D |
| 3 *Schilbeodes gyrinus* (Mitchill) Tadpole stone cat 3 (3) W. | TREMATODES | | |
| | *Acetodextra amiuri* | W 3 * | D |
| | *Alloglossidium corti* | W 1 * | D |
| | COPEPODS | | |
| | *Ergasilus versicolor* | W 1 * | G |

Summary of Parasitism in the Ameiuridae (Siluridae).—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 3 *Schilbeodes miurus* (Jordan) Spotted stone cat 3 (3) W. | TREMATODES | | |
| | *Megalogonia ictaluri* | W 1 * | D |
| | | 1 ** | D |
| | *Neascus* sp. | W 1 * | M |
| | CESTODES | | |
| | *Corallobothrium fimbriatum* | W 1 * | D |
| | *Bothriocephalus* sp. | W 1 * | D |

TABLE 11.

Summary of Parasitism in the Umbridae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 12 *Umbra limi* (Kirtland) Mud minnow 3 (0) E; 9 (6) W. | NEMATODES | | |
| | †*Spiroxys* sp. | W 6 * | D |

TABLE 12.

Summary of Parasitism in the Esocidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 5 *Esox vermiculatus* Le Sueur Little pickerel 5 (1) W. | TREMATODES | | |
| | *Azygia angusticauda* | W 1 * | D |
| | *Centrovarium lobotes* | W 1 * | D |
| | CESTODES | | |
| | *Proteocephalus pinguis* | W 1 * | D |
| | NEMATODES | | |
| | *Spinitectus gracilis* | W 1 * | D |
| 8 *Esox lucius* Linn. Northern pike 6 (6) E; 2 (1) W. | CESTODES | | |
| | *Proteocephalus pinguis* | E 4 * | D |
| | | 2 ** | D |
| | | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | *Neoechinorhynchus tenellus* | E 2 * | D |

TABLE 13.
Summary of Parasitism in the Cyprinodontidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 31 *Fundulus diaphanus menona* Jordan & Copeland | TREMATODES | | |
| | *Neascus vancleavei* | E 3 * | L |
| | | W 4 * | L |
| Top minnow | CESTODES | | |
| 14 (3) E; 17 (10) W. | †*Proteocephalus* sp. | W 1 * | D |
| | NEMATODES | | |
| | *Agamonema* sp. | W 2 * | M |
| | *Rhabdochona* sp. ♯ | E 1 * | D |
| | ACANTHOCEPHALA | | |
| | †*Neoechinorhynchus* sp. | W 5 * | M |
| | | 2 * | L |
| | PROTOZOA | | |
| | Myxosporidia | W 1 ** | F |

♯ Represents a new species, but not enough material secured for an adequate description.

TABLE 14.
Summary of Parasitism in the Percopsidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 53 *Percopsis omiscomaycus* | TREMATODES | | |
| | *Neascus vancleavei* | E 1 * | M |
| | | W 10 * | M |
| Trout perch | | 3 ** | L |
| 7 (5) E; 46 (44) W. | *Crepidostomum isostomum* | E 4 * | D |
| | | W 13 * | D |
| | *Centrovarium lobotes* | E 2 ** | F |
| | *Tetracotyle diminuta* | W 18 * | M |
| | CESTODES | | |
| | †*Triaenophorus* sp. | E 2 * | M |
| | | W 16 * | L & M |
| | *Bothriocephalus cuspidatus* | E 1 * | D |
| | | 2† * | M |
| | *Bothriocephalus claviceps* ♯ | W 4 * | D |
| | *Proteocephalus pearsei* | W 1 * | D |
| | | 5† * | D |
| | NEMATODES | | |
| | *Agamonema* sp. | W 1 * | I |
| | *Camallanus oxycephalus* | W 16 * | D |
| | | 1 ** | D |
| | ACANTHOCEPHALA | | |
| | †*Leptorhynchoides thecatus* | W 1 * | M |
| | PROTOZOA | | |
| | Myxosporidia | W 6 ** | F |

TABLE 15.

Summary of Parasitism in the Serranidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 25 *Lepibema chrysops* Raf. White bass 2 (1) E; 23 (23) W. | TREMATODES | | |
| | *Allacanthochasmus varius* | E 1 ** | D |
| | | W 3 * | D |
| | | 6 ** | D |
| | | 7 *** | D |
| | *Leuceruthrus* sp. | W 2 * | D |
| | *Neascus* sp. | W 5 * | L |
| | | 4 ** | M |
| | Gyrodactyloidea | W 1 * | G |
| | | 4 ** | G |
| | Unidentified | W 1 * | D |
| | CESTODES | | |
| | *Bothriocephalus cuspidatus* | W 7† 5 * | D |
| | | 1 3 ** | D |
| | †*Proteocephalus pearsei* | W 3 * | D |
| | | 5 ** | D |
| | | 1 *** | D |
| | †*Proteocephalus ambloplitis* | W 3 * | M |
| | NEMATODES | | |
| | *Dichelyne cotylophora* | W 1 * | D |
| | *Camallanus oxycephalus* ♯ | W 11 * | D |
| | | 2 ** | D |
| | *Agamonema* sp. | W 1 * | M |
| | *Rhabdochona* sp. | W 1 * | D |
| ♯ One of these identified to genus only. | MOLLUSCA | | |
| | Glochidia | W 1 *** | G |
| 9 Young *L. chrysops* 9 (6) W. | TREMATODES | | |
| | Gyrodactyloidea | W 1 * | G |
| | | 3 ** | G |
| | *Neascus* sp. | W 2 * | M |
| | CESTODES | | |
| | †*Proteocephalus pearsei* | W 2 ** | D |
| | NEMATODES | | |
| | *Camallanus oxycephalus* ♯ | W 2 * | D |
| | *Agamonema* sp. | W 1 * | M |

TABLE 16.

Summary of Parasitism in the Percidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 69 *Perca flavescens* (Mitchill) Yellow perch. 24 (20) E; 45 (40) W. | TREMATODES | | |
| | *Bunodera lucioperca* | E 3 * | D |
| | *Clinostomum marginatum* | W 1 * | F |
| | *Diplostomum scheuringi* | E 2 * | Q |
| | *Crepidostomum cooperi* | W 11 * | D |
| | | 1 ** | D |
| | *Cryptogonimus chyli* | W 1 * | D |
| | | 1 ** | D |
| | *Neascus* sp. | W 2 * | F |
| | | 3 ** | F |
| | *Microphallus opacus* | W 1 * | D |
| | †*Leuceruthrus* sp. | W 1 * | D |
| | CESTODES | | |
| | *Bothriocephalus cuspidatus* | E 1† * | D |
| | | W 6 * | D |
| | | 1 ** | D |
| | *Proteocephalus pearsei* | E 3† * | D |
| | | W 3† * | D |
| | | 8 * | D |
| | †*Proteocephalus ambloplitis* | E 1 * | L |
| | | W 9 * | M |
| | | 1 ** | L & D |
| | †*Triaenophorus* n. sp. | W 2 * | L & D |
| | NEMATODES | | |
| | *Dichelyne cotylophora* | E 12 * | D |
| | | 1 ** | D |
| | | W 20 * | D |
| | | 2 ** | D |
| | *Camallanus oxycephalus* | W 1 * | D |
| | *Philometra cylindracea* | W 1 * | C |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 1 * | M |
| | LEECHES | | |
| | *Piscicola punctata* | E 2 * | E |
| | FUNGUS | | |
| | *Saprolegnia* sp. | E 3 * | F |
| 59 young *P. flavescens* 44 (25) E; 15 (13) W. | TREMATODES | | |
| | *Neascus* sp. | W 1 * | F |
| | CESTODES | | |
| | †*Bothriocephalus cuspidatus* | E 1 ** | D |
| | | W 2 * | D |
| | †*Proteocephalus ambloplitis* | E 3 * | M |
| | | W 7 * | L & M |
| | *Proteocephalus pearsei* | E 3 * | D |
| | | W 1† 9 * | D |
| | | 9 1 ** | D |
| | †*Proteocephalus pinguis* | E 18 * | D |
| | NEMATODES | | |
| | *Dichelyne cotylophora* | W 1 * | D |
| | *Agamonema* sp. | W 2 * | D |

Summary of Parasitism in the Percidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 43 *Stizostedion canadense griseum* (De Kay) Sauger 10 (10) E; 33 (32) W. | TREMATODES | | |
| | *Centrovarium lobotes* | E 1 * | D |
| | | 1 ** | D |
| | | W 5 * | D |
| | *Bucephalus pusillus* | W 4 * | D |
| | | 2 ** | D |
| | *Neascus* sp. | W 1 ** | M |
| | CESTODES | | |
| | *Bothriocephalus cuspidatus* | E 8 * | D |
| | | 2 ** | D |
| | | W 12† 1 * | D |
| | | 17 27 ** | D |
| | | 1 *** | D |
| | *Bothriocephalus claviceps* | E 1 * | D |
| | *Triaenophorus* n. sp. | W 6 * | D, L & M |
| | *Proteocephalus stizostethi* | W 1† ** | D |
| | | 1 ** | D |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 3† * | D |
| | | 9 * | D |
| | ACANTHOCEPHALA | | |
| | *Neoechinorhynchus* sp. | W 1 * | D |
| | COPEPODS | | |
| | *Ergasilus centrarchidarum* | E 3 * | G |
| | | 4 ** | G |
| | *Ergasilus caeruleus* | W 3 * | G |
| | PROTOZOA | | |
| | Myxosporidia | W 1 ** | G |
| | Lymphocystis | W 1 ** | E |
| | MOLLUSCA | | |
| | Glochidia | W 1 ** | G |
| 58 *Stizostedion vitreum* (Mitchill) Wall-eyed pike. 10 (9) E; 48 (47) W. | TREMATODES | | |
| | *Neascus vancleavei* | E 1 * | L |
| | *Neascus* sp. | W 1 * | M |
| | *Azygia angusticauda* | W 1 * | D |
| | *Centrovarium lobotes* | W 2 * | D |
| | *Bucephalus pusillus* | W 3 * | D |
| | | 5 ** | D |
| | CESTODES | | |
| | *Bothriocephalus cuspidatus* | E 6 * | D |
| | | 2 ** | D |
| | | 1 *** | D |
| | | W 20† 8 * | D |
| | | 25 32 ** | D |
| | | 5 *** | D |
| | *Triaenophorus* n. sp. | W 1 * | L |
| | †*Proteocephalus stizostethi* | W 8† 6 * | D |
| | | 5 7 ** | D |
| | NEMATODES | | |
| | *Dichelyne cotylophora* | W 2 * | D |
| | *Camallanus oxycephalus* | W 3 * | D |
| | | 2 ** | D |
| | *Agamonema* sp. | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | *Neoechinorhynchus cylindratus* | E 1 * | D |
| | *Leptorhynchoides thecatus* | W 1 * | D |

Summary of Parasitism in the Percidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 58 *Stizostedion vitreum* (Mitchill) | LEECHES | | |
| | *Piscicola punctata* | W 1 * | E |
| continued | COPEPODS | | |
| | *Ergasilus centrarchidarum* | E 4 ** | G |
| | *Ergasilus caeruleus* | W 4 * | G |
| | | 2 ** | G |
| | PROTOZOA | | |
| | Lymphocystis | W 1 * | 6F |
| | | 3 ** | 1D |
| | | 3 *** | |
| 15 Young *Stizostedion vitreum* | TREMATODES | | |
| | *Neascus* sp. | W 1 * | M |
| 15 (12) W. | *Bucephalus pusillus* | W 1 * | D |
| | | 2 ** | D |
| | CESTODES | | |
| | †*Bothriocephalus cuspidatus* | W 5 * | D |
| | *Triaenophorus* n. sp. | W 1 * | L |
| | †*Proteocephalus ambloplitis* | W 3 * | M |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 3† * | D |
| | | 3 * | D |
| | *Spinitectus gracilis* | W 1 * | D |
| | COPEPODS | | |
| | *Ergasilus caeruleus* | W 1 * | G |
| 20 *Stizostedion glaucum* | TREMATODES | | |
| Blue pike | *Centrovarium lobotes* | W 2 * | D |
| 10 (7) E; 10 (10) W. | *Bucephalus pusillus* | W 2 * | D |
| | | 2 ** | D |
| | CESTODES | | |
| | *Bothriocephalus cuspidatus* | E 5 * | D |
| | | W 4† 13 ** | D |
| | | 11 2 *** | D |
| | *Triaenophorus* n. sp. | W 1 * | D |
| | ‡*Proteocephalus ambloplitis* | W 1 * | D |
| | *Proteocephalus stizostethi* | E 6 * | D |
| | | 1 ** | D |
| | | W 2† 2 * | D |
| | | 5 5 ** | D |
| | NEMATODES | | |
| | *Philometra cylindracea* | W 1 * | C |
| | ACANTHOCEPHALA | | |
| | †*Leptorhynchoides* sp. | W 1 * | M |
| | COPEPODS | | |
| | *Ergasilus caeruleus* | W 2 * | G |
| | | 1 ** | G |
| ‡ Constitutes a new definitive host record. | PROTOZOA | | |
| | Lymphocystis | W 1 ** | E |
| 2 *Hadropterus maculatus* (Girard) | NEMATODES | | |
| Black-sided darter | *Camallanus oxycephalus* | W 1 * | D |
| 2 (1) W. | | | |

Summary of Parasitism in the Percidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 45 *Percina caprodes* (Agassiz) Log perch 13 (9) E; 32 (20) W. | TREMATODES | | |
| | *Diplostomum* sp. | E 1 * | M |
| | *Clinostomum marginatum* | W 1 * | F |
| | *Neascus* sp. | W 1 * | L |
| | *Leuceruthrus* sp. | W 1 * | D |
| | *Allocreadium boleosomi* | W 2 * | D |
| | *Tetracotyle* sp. | W 4 * | M |
| | CESTODES | | |
| | †*Bothriocephalus cuspidatus* | E 1 * | D |
| | *Proteocephalus pearsei* | W 1 * | D |
| | †*Proteocephalus stizostethi* | W 2 * | D |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 8 * | D |
| | | 1 ** | D |
| | *Agamonema* sp. | W 3 * | 2M, 1D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | E 7 * | M & I |
| | | W 6† 6 * | 6 M |
| | | 1 1 ** | 1 D |
| | LEECHES | | |
| | *Piscicola punctata* | W 2 * | E |
| | PROTOZOA | | |
| | Myxosporidia | W 1 * | G |
| | | 2 ** | G |
| 34 *Rheocrypta copelandi* Jordan Copeland's darter 34 (8) W. | TREMATODES | | |
| | *Neascus* sp. | W 6 * | L & M |
| | *Lebouria cooperi* | W 3 * | D |
| | CESTODES | | |
| | *Bothriocephalus cuspidatus* | W 1 * | D |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 1 * | M |
| 15 *Ammocrypta pellucida* (Baird) Sand darter 15 (9) W. | TREMATODES | | |
| | *Neascus* sp. | W 1 * | L |
| | *Tetracotyle* sp. | W 3 * | M |
| | *Lebouria cooperi* | W 1 * | D |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 3 * | D |
| | *Agamonema* sp. | W 6 * | D |
| 23 *Boleosoma nigrum* (Raf.) Johnny darter 7 (2) E; 16 (13) W. | TREMATODES | | |
| | *Clinostomum marginatum* | E 1 * | F |
| | †*Leuceruthrus* sp. | W 1 * | D |
| | *Neascus vancleavei* | W 4 * | L |
| | | 3 ** | M |
| | *Neascus* sp. | E 1 ** | F |
| | CESTODES | | |
| | *Proteocephalus pearsei* | E 1 * | D |
| | NEMATODES | | |
| | *Agamonema* sp. | W 4 * | D |
| | | 2 ** | D |

Summary of Parasitism in the Percidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 7 *Poecilichthys exilis* (Girard) Iowa darter 7 (5) W. | TREMATODES | | |
| | *Allocreadium* sp. | W 1 * | D |
| | *Tetracotyle sp.* | W 1 * | M |
| | CESTODES | | |
| | †*Bothriocephalus cuspidatus* | W 1 * | D |
| | NEMATODES | | |
| | *Agamonema* sp. | W 5 * | 2 M 2 D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 1 * | D |
| 23 *Catonotus flabellaris* (Raf.) Fan-tailed darter 18 (10) E; 5 (1) W. | TREMATODES | | |
| | *Clinostomum marginatum* | E 1 * | F |
| | *Neascus* sp. | E 5 * | F |
| | | 1 ** | F |
| | | W 1 * | F |
| | *Tetracotyle communis* | E 3 * | P |
| 10 *Etheostoma blennoides* Raf. Green-sided darter 10 (3) W. | TREMATODES | | |
| | *Allocreadium* sp. | W 1 * | D |
| | *Tetracotyle* sp. | W 1 * | M |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 1 * | D |
| | FUNGUS | | |
| | *Saprolegnia* sp. | W 1 ** | E |

One *Poecilichthys coeruleus* Storer, the rainbow darter, was examined from the eastern end of Lake Erie and was found to be negative, as were four least darters, *Microperca punctulata* Putnam, from the western end of the lake.

TABLE 17.

Summary of Parasitism in the Centrarchidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 57 *Micropterus dolomieu* Lacépède Small-mouthed black bass 28 (24) E; 29 (28) W. | TREMATODES | | |
| | *Crepidostomum cornutum* | E 4 * | D |
| | | 4 ** | D |
| | | 8 *** | D |
| | | W 10 * | D |
| | *Centrovarium lobotes* | E 1 ** | D |
| | | W 1 * | D |
| | *Leucerythrus micropteri* | W 5 * | D |
| | *Cryptogonimus chyli* | E 1 ** | D |
| | | 2 *** | D |
| | | W 6 ** | D |
| | Gyrodactyloidea | W 1 ** | G |
| | CESTODES | | |
| | *Proteocephalus ambloplitis* | E 11 * | D |
| | | 2† ** | M, L S & R |
| | | W 7 * | D |
| | | 14† ** | L, S, R & M |
| | †*Triaenophorus* sp. | W 1 * | L |
| | *Bothriocephalus claviceps* | W 1 * | D |
| | *Proteocephalus pearsei* | W 2 * | D |
| | *Proteocephalus fluviatilis* | W 1 * | D |

Summary of Parasitism in the Centrarchidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 57 *Micropterus dolomieu* Lacépède | NEMATODES | | |
| | *Spinitectus carolini* | E 9 * | D |
| | | W 3 * | D |
| continued | *Agamonema* sp. | E 2 * | D |
| | | 4 ** | D |
| | *Dichelyne cotylophora* | E 3 * | D |
| | *Camallanus oxycephalus* | W 2 * | D |
| | ACANTHOCEPHALA | | |
| | *Neoechinorhynchus cylindratus* | E 1 * | D |
| | *Leptorhynchoides thecatus* | E 9 * | D |
| | | 7 ** | D |
| | | 1 *** | D |
| | | W 5 * | 20 D |
| | | 11 ** | 1 M |
| | | 5 *** | |
| | COPEPODS | | |
| | *Ergasilus centrarchidarum* | E 4 * | G |
| | | 1 *** | G |
| | | W 2 * | G |
| | *Achtheres micropteri* | W 2 * | G |
| | *Achtheres ambloplitis* | E 1 * | G |
| | Lernaeidae | W 1 * | F |
| | PROTOZOA | | |
| | *Myxobolus* sp. | W 1 * | G |
| | *Ichthyophthirius multifiliis* | W 1 ** | E |
| | FUNGUS | | |
| | *Saprolegnia parasitica* | W 1 * | G & E |
| 64 young *M. dolomieu* 13 (7) E; 51 (48) W. | TREMATODES | | |
| | *Crepidostomum cornutum* | E 2 * | D |
| | | W 1 * | D |
| | *Cryptogonimus chyli* | W 4 * | D |
| | | 5 ** | D |
| | Gyrodactyloidea | W 2 * | G |
| | | 1 ** | G |
| | *Clinostomum marginatum* | W 1 * | F |
| | *Microphallus opacus* | W 1 * | D |
| | *Neochasmus umbellus* | W 2 * | D |
| | | 1 ** | D |
| | *Azygia angusticauda* | W 1 * | D |
| | *Bucephalus papillosus* | W 1 * | D |
| | CESTODES | | |
| | †*Proteocephalus ambloplitis* | E 4 * | L |
| | | 1 ** | M & R |
| | | W 20 * | L |
| | | 3 * | M & R |
| | *Proteocephalus pearsei* | W 12 * | D |
| | | 9 ** | D |
| | NEMATODES | | |
| | *Spinitectus carolini* | E 2 * | D |
| | | W 1 * | D |
| | *Camallanus oxycephalus* | W 8 * | D |
| | *Agamonema* sp. | W 3 * | D & M |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | E 1 * | D |
| | | W 5† * | M |
| | *Neoechinorhynchus cylindratus* | W 1 * | D |
| | LEECHES | | |
| | *Piscicola punctata* | W 1 * | E |

Summary of Parasitism in the Centrarchidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 27 *Aplites salmoides* (Lacépède) Large-mouthed black bass 3 (2) E; 24 (20) W. | TREMATODES | | |
| | *Crepidostomum cornutum* | E 1 * | D |
| | *Leuceruthrus micropteri* | W 4 * | D |
| | *Cryptogonimus chyli* | W 4 ** | D |
| | Gyrodactyloidea | W 3 ** | G |
| | CESTODES | | |
| | *Proteocephalus ambloplitis* | E 1 * | D |
| | | 1† ** | M & L |
| | | W 8 * | L, M, R, S |
| | | 2 ** | L, M, R, S |
| | *Proteocephalus pearsei* | W 3 * | D |
| | NEMATODES | | |
| | *Spinitectus carolini* | E 1 * | D |
| | *Contracaecum brachyurum* | W 1 * | D |
| | *Dioctophyme* sp. | W 1 * | C |
| | *Camallanus oxycephalus* | W 1 * | D |
| | *Dichelyne cotylophora* | W 1 * | D |
| | *Agamonema* sp. | W 1 * | S |
| | ACANTHOCEPHALA | | |
| | *Neoechinorhynchus cylindratus* | E 1 * | D |
| | | W 5 * | D |
| | | 8 ** | D |
| | *Leptorhynchoides thecatus* | W 2 * | D |
| | | 2 ** | D |
| | COPEPODS | | |
| | *Ergasilus centrarchidarum* | E 1 * | G |
| | | W 2 ** | G |
| | *Achtheres micropteri* | W 2 * | G |
| | PROTOZOA | | |
| | *Myxobolus* sp. | W 1 * | G |
| 105 young *A. salmoides* 105 (87) W. | TREMATODES | | |
| | *Leuceruthrus micropteri* | W 18 * | D |
| | *Cryptogonimus chyli* | W 6 * | D |
| | | 4 ** | D |
| | *Neascus vancleavei* | W 4 * | L |
| | Gyrodactyloidea | W 4 * | G |
| | | 6 ** | G |
| | CESTODES | | |
| | *Proteocephalus pearsei* | W 6 * | D |
| | *Proteocephalus ambloplitis* | W 24 * | 5D |
| | | 12 ** | L, M |
| | | 1 *** | |
| | NEMATODES | | |
| | *Dioctophyme* sp. | W 1 * | C |
| | *Camallanus oxycephalus* | W 2 * | D |
| | *Agamonema* sp. | W 1 * | L |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 10 * | 5 D |
| | | 1 ** | 6 M |
| | *Neoechinorhynchus cylindratus* | W 7 * | D |
| | COPEPODS | | |
| | *Ergasilus centrarchidarum* | W 6 * | G |
| | *Achtheres micropteri* | W 1 * | G |
| | PROTOZOA | | |
| | Myxosporidia | W 4 * | G |
| | | 14 ** | G |
| | | 7 *** | G |
| | *Cyclochaeta domerguei* | W 1 ** | E |
| | Vorticellidae | W 2 *** | E |

Summary of Parasitism in the Centdarchidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 105 young *A. salmoides* continued | LEECHES | | |
| | *Plaeobdella montifera* | W 1 * | E |
| | FUNGUS | | |
| | *Saprolegnia* sp. | W 1 * | E |
| 10 *Helioperca incisor* (Cuvier & Valenciennes) Blue gill 10 (8) W. | TREMATODES | | |
| | Gyrodactyloidea | W 1 * | G |
| | | 2 ** | G |
| | *Clinostomum marginatum* | W 1 * | F |
| | *Tetracotyle* sp. | W 1 * | P |
| | *Neascus vancleavei* | W 1 * | L |
| | | 2 ** | L |
| | *Crassiphiala ambloplitis* | W 1 * | F |
| | CESTODES | | |
| | *Proteocephalus pearsei* | W 1 * | D |
| | *Proteocephalus ambloplitis* | W 2† * | L & D |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 1 * | D |
| | *Dichelyne cotylophora* | W 1 * | D |
| | *Rhabdochona* sp. | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 3 * | 3 M 1 D |
| | COPEPODS | | |
| | *Ergasilus centrarchidarum* | W 1 * | G |
| | LEECHES | | |
| | *Piscicola punctata* | W 2 * | E |
| | MOLLUSCA | | |
| | Glochidia | W 1 ** | G |
| 41 *Eupomotis gibbosus* (Linn.) Pumpkinseed 18 (12) E; 23 (19) W. | TREMATODES | | |
| | *Allocreadium* sp. | E 4 * | D |
| | *Crassiphiala ambloplitis* | E 3 *** | F |
| | *Neascus vancleavei* | E 2 * | L & M |
| | | W 5 * | L |
| | | 2 ** | L |
| | *Clinostomum marginatum* | W 1 * | F |
| | Unidentified | W 2 * | D |
| | CESTODES | | |
| | †*Bothriocephalus* sp. | E 1 ** | D |
| | †*Proteocephalus ambloplitis* | E 4 * | L & M |
| | | W 6 * | L & M |
| | NEMATODES | | |
| | *Spinitectus carolini* | E 4 * | D |
| | | W 1 * | D |
| | *Agamonema* sp. | E 3 * | D |
| | | W 1 * | D |
| | *Camallanus oxycephalus* | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | E 1 * | D |
| | | W 3† * | 2 M 1 D |
| | PROTOZOA | | |
| | Myxosporidia | W 3 *** | G |
| | LEECHES | | |
| | *Piscicola punctata* | W 1 * | E |

Summary of Parasitism in the Centrarchidae.—Continued

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 40 *Ambloplites rupestris* (Raf.) Rock bass 28 (21) E; 12 (11) W. | TREMATODES | | |
| | *Leuceruthrus micropteri* | E 6 * | D |
| | *Cryptogonimus chyli* | E 3 * | D |
| | | W 4 * | D |
| | | 1 ** | D |
| | *Crassiphiala ambloplitis* | E 7 *** | F |
| | | W 2 ** | F |
| | *Crepidostomum cornutum* | W 2 * | D |
| | *Clinostomum marginatum* | W 1 * | F |
| | *Neascus vancleavei* | W 2 * | M |
| | CESTODES | | |
| | *Proteocephalus pearsei* | E 2 * | D |
| | *Proteocephalus ambloplitis* | E 1† * | L |
| | | 1† ** | M |
| | | W 2 * | D |
| | *Bothriocephalus claviceps* | W 1 * | D |
| | NEMATODES | | |
| | *Spinitectus carolini* | E 5 * | D |
| | | W 4 * | D |
| | *Contracaecum* sp. | W 1 * | D |
| | *Camallanus oxycephalus* | W 2 * | D |
| | *Agamonema* sp. | W 1 * | D |
| | *Rhabdochona* sp. | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | E 3 * | D |
| | | W 5† * | 3 M 2 D |
| 15 young *A. rupestris* examined from eastern end of Lake Erie were negative. | COPEPODS | | |
| | *Ergasilus centrarchidarum* | E 2 * | G |
| | | W 1 ** | G |
| | *Achtheres ambloplitis* | W 4 * | G |
| 25 *Pomoxis annularis* Raf. White crappie 8 (1) E; 17 (8) W. | NEMATODES | | |
| | *Spinitectus gracilis* | E 1 * | D |
| | *Camallanus oycephalus* | W 4 * | D |
| | *Agamonema* sp. | W 2 * | D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 5 * | D |
| | PROTOZOA | | |
| | Myxosporidia | W 1 ** | G |
| 9 *Pomoxis sparoides* (Lacépède) Calico bass 9 (4) W. | TREMATODES | | |
| | *Neascus vancleavei* | W 1 * | M |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 1 * | D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 1 * | M |
| | MOLLUSCA | | |
| | Glochidia | W 1 * | G |
| 1 *Xenotis megalotis* (Raf.) Long-eared sunfish 1 (1) W. | TREMATODES | | |
| | *Neascus vancleavei* | W 1 * | L |

One *Apomotis cyanellus* from the western end was negative.

TABLE 18.

Summary of Parasitism in the Atherinidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 45 *Labidesthes sicculus* (Cope) Brook silversides 15 (0) E; 30 (10) W. | TREMATODES | | |
| | *Neascus* sp. | W 2 * | L |
| | †*Allacanthochasmus varius* | W 1 * | M |
| | †*Allocreadium* sp. (1213) | W 1 * | D |
| | CESTODES | | |
| | †*Bothriocephalus* sp. | W 1 * | D |
| | †*Proteocephalus ambloplitis* | W 1 * | L & M |
| | NEMATODES | | |
| | *Agamonema* sp. | W 2 * | M |
| | | 2 * | D |
| | *Camallanus oxycephalus* | W 1 * | D |
| | | 1 †* | D |

TABLE 19.

Summary of Parasitism in the Sciaenidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 48 *Aplodinotus grunniens* Raf. Sheepshead 3 (3) E; 45 (41) W. ‡ Lost. Identified to genus only. | TREMATODES | | |
| | *Anallocreadium armatum* | E 1 * | D |
| | *Anallocreadium pearsei* | W 8 * | D |
| | | 2 ** | D |
| | *Crepidostomum* sp. ‡ | W 1 * | D |
| | *Microcotyle spinicirrus* | W 5 * | D |
| | *Microcotyle eriensis* | W 5 * | D |
| | *Neascus* sp. | W 9 * | M |
| | | 5 ** | M |
| | *Tetracotyle* sp. | W 1 * | M |
| | CESTODES | | |
| | *Bothriocephalus claviceps* | E 2 * | D |
| | †*Bothriocephalus cuspidatus* | W 5 * | D |
| | †*Proteocephalus pearsei* | W 2 * | D |
| | NEMATODES | | |
| | *Camallanus oxycephalus* | W 10 †* | 1 C |
| | | 8 * | 18 D |
| | *Dichelyne cotylophora* | E 1 * | D |
| | | W 2 * | D |
| | *Spinitectus gracilis* | W 1 * | D |
| | *Philometra cylindracea* | W 6 * | D |
| | *Agamonema* sp. | W 5 * | 3 M |
| | | | 2 D |
| | ACANTHOCEPHALA | | |
| | *Leptorhynchoides thecatus* | W 1 * | D |
| | PROTOZOA | | |
| | Myxosporidia | W 2 ** | G |
| | LEECHES | | |
| | *Piscicola punctata* | W 2 * | E |
| | MOLLUSCA | | |
| | Glochidia | W 8 * | G |
| | | 7 ** | G |
| | | 1 *** | G |

TABLE 20.
Summary of Parasitism in the Cottidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 7 *Cottus bairdii* Girard | CESTODES | | |
| Miller's thumb | †*Proteocephalus ambloplitis* | W 1 * | L |
| 7 (2) W. | †*Proteocephalus* sp. | W 1 * | D |

TABLE 21.
Summary of Parasitism in the Gasterosteidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 22 *Eucalia inconstans* | TREMATODES | | |
| (Kirtland) | *Bunoderina eucaliae* | E 1 * | D |
| Brook stickleback | CESTODES | | |
| 20 (3) E; 2 (1) W | †*Proteocephalus* sp. | W 1 * | D |
| | NEMATODES | | |
| | *Agamonema* sp. | E 2 * | D |

TABLE 22.
Summary of Parasitism in the Gadidae.

| *Hosts* | *Parasites* | *Number infected & degree* | *Location in host* |
|---|---|---|---|
| 10 *Lota maculosa* | CESTODES | | |
| (Le Sueur) | *Abothrium crassum* | E 1 * | D |
| Burbot, ling | | 1 ** | D |
| 3 (3) E; 7 (7) W. | | 1 *** | D |
| | | W 2 * | 7 D |
| | | 5 ** | 5 I |
| | NEMATODES | | |
| | *Haplonema hamulatum* | E 1 * | D |
| | | 1 ** | D |
| | ACANTHOCEPHALA | | |
| | *Echinorhynchus coregoni* | E 2 * | D |
| | | 1 ** | D |
| | LEECHES | | |
| | *Piscicola punctata* | W 3 * | E |

Trematodes and Acanthocephala were recovered from two hosts at the western end, but the material was lost prior to identification.